OPHTHALMIC PRACTICE

LEWIS'S PRACTICAL SERIES

HIGGENS

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OPHTHALMIC PRACTICE

A MANUAL

OF

OPHTHALMIC PRACTICE

BY

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WITH ILLUSTRATIONS

LONDON

H. K. LEWIS, 136 GOWER STREET, W.C.

1888

PRINTED BY
H. K. LEWIS, 136 GOWER STREET
LONDON, W.C.

PREFACE.

In the preparation of this little work, I have been guided by the experience of fourteen years teaching at Guy's Hospital, and have tried to make it meet the requirements of students and general practitioners, so far as I know them. I have endeavoured to be as concise and practical as possible.

I have to thank Mr. F. Durham for much valuable assistance in seeing the sheets through the press.

38 Brook Street, W.

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MANUAL OF OPHTHALMIC PRACTICE.

CHAPTER I.

Optical and General Outlines.

Refraction.—The following outline of the phenomena of refraction has been in a great measure compiled from "Ganot's Elementary Physics"* from which the diagrams have also been adapted.

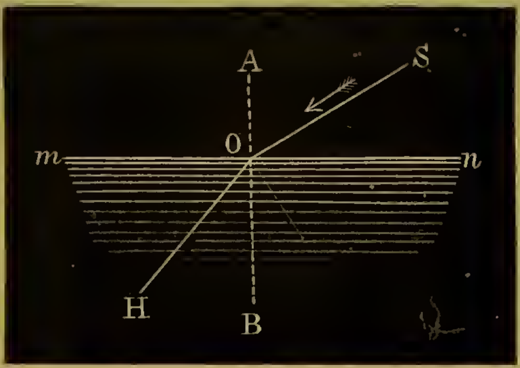

Fig. 1.

Refraction is the deviation which luminous rays experience when passing obliquely from one medium to another, for instance from air into water; we say *obliquely*, because if the incident ray is perpendicular to the surface, separating the two media, it is not deflected but continues its course in a right line.

* Ninth Edition, translated by E. Atkinson, Ph.D.

The *incident ray* being represented by SO (Fig. 1) the *refracted ray* is the direction OH, which light takes in the second medium, and of the angles SOA and HOB, which these rays form with the "normal"* AB, at right angles to the surface which separates the two media, the first is the *angle of incidence* and the other the *angle of refraction.* According as the refracted ray approaches or deviates from the normal, the second

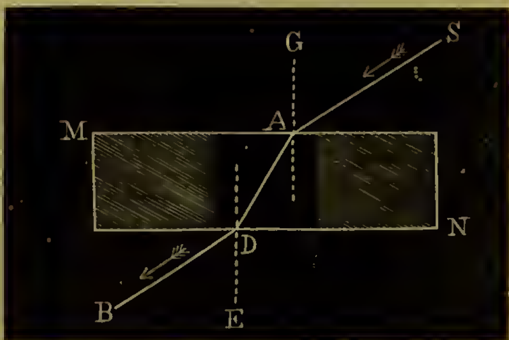

FIG. 2.

medium is said to be more or less refringent or refracting than the first.

TRANSMISSION OF LIGHT THROUGH TRANSPARENT MEDIA.

Media with parallel faces.—When light traverses a medium with parallel faces the *emergent* rays are parallel to the incident rays, as shown in Fig. 2 in which SA is the incident ray, AD the refracted ray and DB the emergent ray, G and E are the normals to the two

* The line perpendicular to the surface separating the two media (AB in diagram).

surfaces. But when light traverses media the surfaces of which are not parallel, the emergent ray is not parallel to the incident ray; upon this depends the action of prisms and lenses.

Prism.—In optics a prism is any transparent medium comprised between two plane faces inclined to each other. The intersection of these two faces is the *edge* of the prism, and their inclination is its refracting angle.

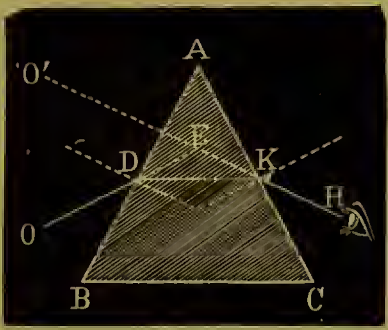

FIG. 3.

Path of rays in prisms.—When the laws of refraction are known the path of rays in a prism is readily determined. Let O (Fig. 3) be a luminous point, ABC, a section of a prism made of glass, of which A is called the summit, BC the base, and OD an incident ray. This ray is refracted at D and approaches the normal, because it passes into a more highly refracting medium (see p. 2). At K it experiences a *second* refraction, but it then deviates from the normal, for it passes into air which is less refractive than glass (see also p. 2). The light is thus refracted twice in the same direction, and the eye which receives the emergent ray KH, sees the object O at O′; that is *objects seen through a prism appear displaced towards its edge or summit.* Prisms are numbered by the degree of inclination of their surfaces; we speak of a prism of so many degrees.

Lenses.—We next come to the consideration of lenses. These are transparent media which from the curvature of their surfaces, have the property of causing luminous rays which traverse them either to converge or diverge. According to their curvature, they are either spherical, cylindrical, elliptical or parabolic. We have to consider only spherical and cylindrical lenses. These are usually made of crown or flint glass, of which the latter

FIG. 4.

is the more highly refractive; spectacle lenses are frequently made of what is known among opticians as "pebble" or rock crystal which is harder than glass and does not easily scratch.

The combination of spherical surfaces, either with each other or with a plane surface, gives rise to six kinds of lenses, sections of which are represented in Fig. 4. Four are formed by two spherical surfaces, and two by plane and spherical surfaces. A is a *double convex*, B is a *plano-convex*, C is a *converging concavo-convex*, D is a *double concave*, E is a *plano-concave*, F is a *diverging concavo-convex*. The lens C is called the *converging meniscus*, and the lens F the *diverging meniscus*.

The first three, which are thicker at the centre than at

the borders, are converging; the others which are thinner in the centre are diverging. In the first group the double convex lens only need be considered, and in the second the double concave, as the properties of each of these lenses apply to all those of the same group. The spherical lenses used in ophthalmic practice are almost always double convex, or double concave, but occasionally a plano-convex, or plano-concave, or a meniscus may be found useful.

Centres of curvature and principal axis.—In lenses whose two surfaces are spherical the centres for the surfaces are called *centres of curvature* and the right line which passes through these two centres is the *principal axis.*

In considering the path of rays through lenses, we may compare them with prisms; the convex ABC may be looked upon as a succession of prisms having their summits outwards, the concave DEF as a series with their summits inwards. From this we see that the former ought to condense the rays and the latter to disperse them; for we have already seen that when a ray of light traverses a prism it is deflected towards its base.

Foci in double convex lenses.—The focus of a lens is the point where the refracted rays or their prolongations meet. Double convex lenses have what are known as real and virtual foci.

Real foci.—We will first consider the case in which the luminous rays falling on the lens are *parallel to its principal axis* (Fig. 5). In this case any incident ray LB, in approaching the normal of the point of incidence B and in diverging from the normal at the point of emergence D, is twice refracted towards the axis, which it cuts at the point F. As all rays parallel to the axis are refracted in the same manner, it can be shown that they all pass very nearly through the point F. This point is

called the *principal focus*, and the distance FA is the principal *focal distance or focal length of the lens.*

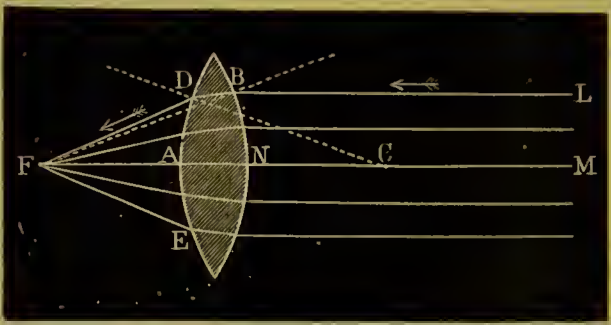

FIG. 5.

Conjugate foci.—We will now consider the case in which the luminous object is further from the lens than its principal focus, but so near that all incident rays of light form a divergent pencil, as shown (Fig. 6). The

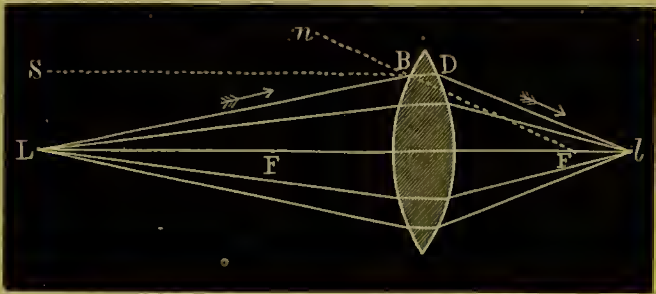

FIG. 6.

luminous point being at L, by comparing the path of the diverging ray LB with that of the ray SB parallel to the axis, the former is found to make with the normal an

angle, LB*n*, greater than the angle SB*n*; the angle of refraction is consequently greater, and after traversing the lens, the ray cuts the axis at a point *l* which is more distant than the principal focus F. As all rays from the point L cut the axis approximately at *l*, this point is what is called the *conjugate focus* of the point L. The term conjugate focus expresses the relation existing between the two points L and *l*, which is of such a nature that if the luminous point be removed to *l*, the focus passes to L.

Accordingly as the object comes nearer the lens, the divergence of the emergent rays increases and the focus

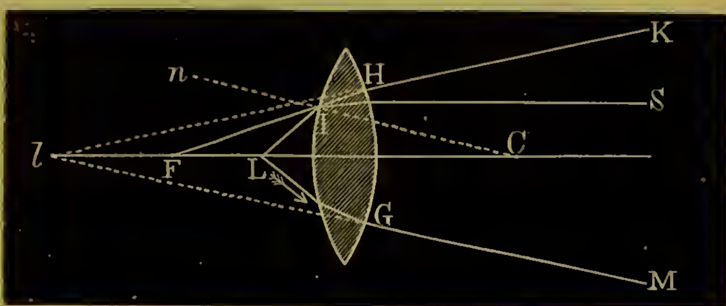

FIG. 7.

l becomes more distant; when the luminous point L coincides with the principal focus, the emergent rays on the other side of the lens are parallel to the axis, and there is no focus, or what is the same thing it is infinitely distant.

Virtual foci.—A double convex lens has a virtual focus when the luminous object L is placed between the lens and the principal focus as shown (Fig 7). In this case the incident rays LI make with the normal greater angles than those made by the rays FI from the principal focus F; hence when the former rays emerge they move further from the axis than the latter and form a

diverging pencil HK GM. These rays cannot produce a real focus, but their prolongations in the opposite direction meet in some point *l* on the axis, and this point is the virtual focus of the point L.

Foci in double concave lenses.—In double concave lenses there are only virtual foci, whatever the distance of the object. In Fig. 8 let SI, S′K be any pencil of rays parallel to the axis, any ray SI, is refracted at the point of incidence I and approaches the normal CI.

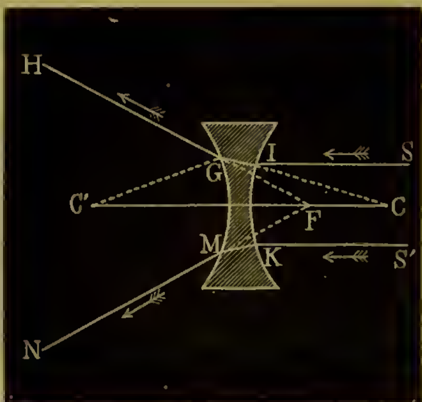

FIG. 8.

At the point of emergence it is again refracted, but diverges from the normal GC′. So that it is twice refracted in a direction which moves it from the axis CC′. As the same thing takes place for every other ray, S′KMN, it follows that the rays after traversing the lens form a diverging pencil GH, MN. Hence there is no real focus, but the prolongations of these rays in the opposite direction cut one another in a point F, which is the principal virtual focus.

In the case in which the rays proceed from some point L on the axis, and form a diverging instead of a

parallel pencil (Fig. 9), it is found that a virtual focus is formed at *l*, which is between the principal focus and

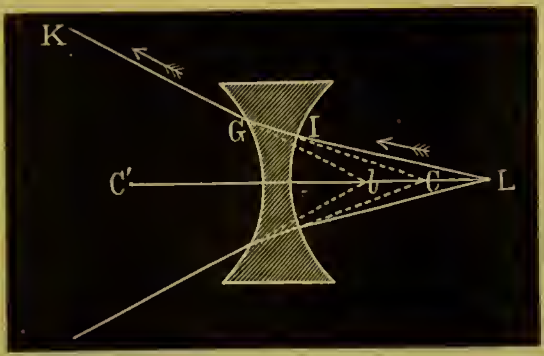

FIG. 9.

the lens and which may be considered the conjugate focus of the point L.

Optical centre and secondary axis.—In every lens there is a point called the *optical centre*, which is situated on the principal axis, and which has the property that

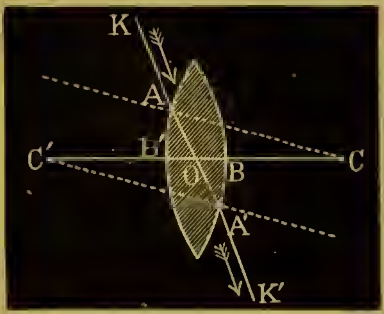

FIG. 10.

any luminous ray passing through this point experiences no angular deviation, that is, that the emergent ray is parallel to the incident ray. The existence of this point may be demonstrated in the following manner:—let two parallel radii of curvature C A and C′ A′ (Fig. 10) be

drawn to the two surfaces of a double convex lens. As the two plane elements of the lens A and A′ are parallel being perpendicular to two parallel right lines, it will be granted that the refracted ray K A A′ K′ is propagated in a medium with parallel faces. Hence a ray which reaches A at such an inclination that, after refraction it takes the direction A A′, will emerge parallel to its first direction (see Fig. 2, p. 2); the point O, at which the right line cuts the principal axis is, therefore, the optical centre. Every right line P P′ (Fig. 11) which

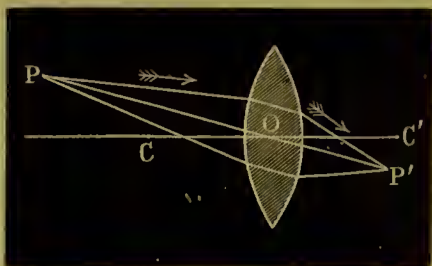

FIG. 11.

passes through the optical centre without passing through the centres of curvature is a *secondary axis*. From the property of the optical centre, every secondary axis represents a luminous rectilinear ray passing through this point, for from the slight thickness of the lenses it may be assumed that rays passing through the optical centre are in a right line, that is, that the small deviation which rays experience in passing through a medium with parallel faces may be neglected (see Fig. 2, p. 2).

Nodal points.—If, however, we take into consideration this deviation, we have to notice what are known as "*Nodal points*." The anterior nodal point *k′* (Fig. 12) is the point upon the principal axis A A to which the ray *a b* appears to be directed before refraction; the posterior

nodal point k'' is the point from which the emergent ray $c\,d$ appears to proceed; the direction of the emergent ray is, however, parallel to that of the incident ray.

So long as the secondary axes make only small angles with the principal axis, all that has been said about the principal axis is applicable to them; that is, that rays of light emitted from a point P (Fig. 11) on the secondary axis P P′, nearly coincide in the same point

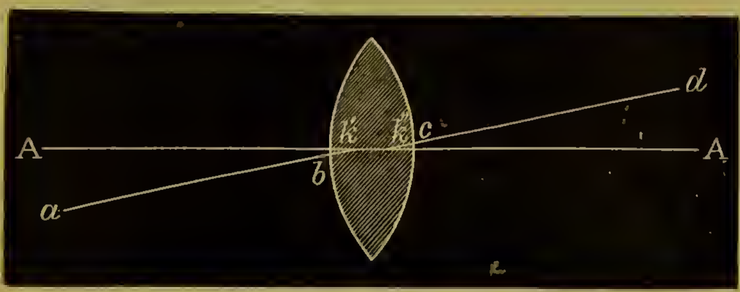

FIG. 12.

of this axis P′ and accordingly as the distance from the point P to the lens is greater or less than the principal focal distance, the focus will be either conjugate or virtual.

Formation of images in double convex lenses.—In lenses the image of an object is the collection of the foci of each of its points; hence the images furnished by lenses are real or virtual in the same cases as their foci, and their construction resolves itself into determining a series of points.

Real image.—Let A B (Fig. 13) be placed beyond the principal focus. If a secondary axis A *a* be drawn from the outside point A, any ray A C from this point will be twice refracted at C and D, and both times in the same direction, approaching the secondary axis which it cuts

at *a*. From what has just been said (p. 11), the other rays from the point A, will coincide in the point *a*,

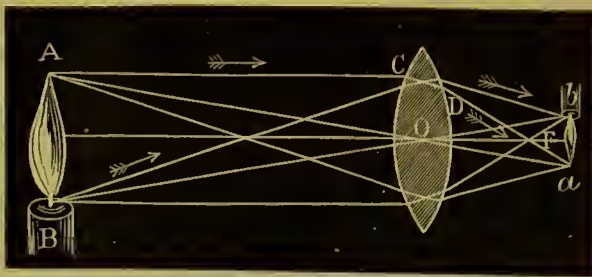

FIG. 13.

which is accordingly the conjugate focus of the point A. If the secondary axis be drawn from the point B, it will be seen in like manner, that the rays from this point coincide in the point *b*, and as the points between A and B have their foci between *a* and *b*, a *real* image of

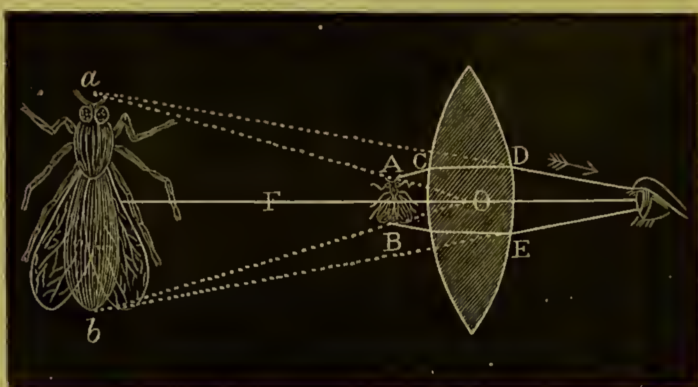

FIG. 14.

A B will be formed at *a b*, which is inverted and smaller than the object A B.

Virtual image.—There is another case in which the object AB (Fig. 14) is placed between the lens and its

principal focus. If a secondary axis, O*a*, be drawn through the point A, every ray AC after having been twice refracted, diverges in emerging from this axis, since the point A is at a less distance than the principal focus (see Fig. 7, p. 7). This ray continued in the opposite direction will cut the axis O*a* in the point *a*, which is the virtual focus of the point A. Tracing the secondary axis of the point B, it will be found in the same manner that the virtual focus of this point is formed at *b*. There is, therefore, an image of AB at *ab*. This is a virtual image, it is in its right position, and is larger than the object.

Formation of images in double concave lenses. Double concave lenses give only virtual foci, whatever the distance of the object. Let AB (Fig. 15) be an

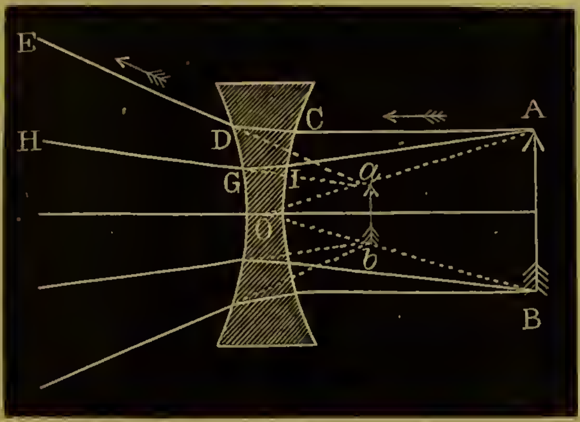

FIG. 15.

object placed in front of such a lens. If the secondary axis AO be drawn from the point A, all rays, AC, AI, from this point are twice refracted in the same direction, diverging from the axis AO; so that the eye receiving the emergent rays DE and GH, supposes them to proceed from the point where their continuations cut the secondary axis AO, in the point *a*.

In like manner drawing a secondary axis from the point B, the rays from this point form a pencil of diverging rays, the directions of which prolonged, coincide in the point *b*, on the secondary axis BO. Hence the eye sees at *ab* a virtual image of AB which is in its right position, and is smaller than the object.

Cylindrical Lens.

A cylindrical lens convex or concave is ground upon a cylindrical surface and differs from a spherical in having what is known as an axis, in the direction of which there is no curvature; so that all rays of light passing through such a lens in the direction of its axis undergo no refraction, or at least only such as is experienced by rays passing through media with parallel surfaces (see Fig. 2, p. 2). All other rays passing through the lens are refracted; those in planes making small angles with the axis but little, those in planes making larger angles with the axis more, those in a plane at right angles to the axis most of all; so that we see the most powerful action of a cylindrical lens is in a direction at *right angles* to its axis. The direction of the refracted rays is either convergent or divergent according as the lens is convex or concave.

We can always ascertain the convex or concave curvature, as well as the axis of a cylindrical lens by allowing the light from a lamp situated at some six or eight feet distance to pass through it, and fall upon a screen placed from eight inches to three feet, or rather more, behind the lens according to its strength (nearer to it if the lens be strong, further from it if the lens be weak) and noticing the kind of figure formed upon the screen,

if the lens be convex the figure will have dark margins and a bright oval centre the long axis of the oval *corresponding* to the axis of the lens. If the lens be concave the figure will have a dark centre and bright edges forming altogether an oval, the long axis of which is at *right angles* to the axis of the lens.

Refraction of the Eye.

In the eye there are three refractive surfaces; the front of the cornea, the front of the lens and the front of the vitreous; we may consider these combined dioptric media as one biconvex lens, at the principal focus of which, in the normally shaped or *emmetropic* eye when its accommodation is relaxed the retina is situated; *i.e.* the emmetropic eye with accommodative rest is adapted for parallel rays.

Visual line and visual angle.—The former signifies an imaginary line drawn from the yellow spot to the centre of the object looked at; the latter is the angle formed by two secondary axes drawn from what is known as the optical or more correctly the posterior nodal point of the eye (a point situated a little behind the crystalline lens) to the extremities of the object looked at. The visual line does not correspond with the optic axis, but cuts the cornea rather below and internal to its centre, and forms with the optic axis, an angle which varies in size according to the shape of the eyeball.

Conditions of normal vision.—In order that an object may be seen distinctly, the following optical conditions must be fulfilled. A well defined inverted image must be formed in the yellow spot. The image

must have a certain size, the minimum corresponding to a visual angle of five minutes ($\frac{1}{12}$ of a degree).

Certain terms are applied to the eyeball in order to designate different parts and divide it into regions. Thus, a point at the summit of the cornea is known as the anterior pole of the eyeball, a corresponding one at the most remote part of the fundus between the yellow spot and optic disc as the posterior pole; an imaginary line passing through the two as the axis of the globe or optic axis; another imaginary line passing around the globe midway between the two poles is known as the equator, and the portion in front of the equator is known as the anterior hemisphere, that behind as the posterior hemisphere of the globe.

We also divide the eyeball in an antero-posterior direction by imaginary lines, on its surface passing through the poles and corresponding to the axis called meridians; it is obvious that any number of such lines may be drawn, but for practical purposes it is only necessary to distinguish two; a horizontal meridian dividing the globe into superior and inferior halves, and a vertical meridian dividing it into equal lateral portions. The narrow zone nearest the cornea is known as the sclero-corneal junction or margin, and a wider band next it corresponding to the ciliary body internally is called the ciliary region. We also distinguish the "centre of rotation" a point situated on the optic axis about two-thirds of its length from the cornea.

Trial glasses.—The trial glasses, which are now very generally in use, are arranged according to what is known as the "metrical system." The unit in this system is a lens of one metre focal length; it is called a "dioptric" or "dioptrie" (=D). A lens of two dioptrics is double the strength of that of one dioptric, and has a focal length of half a metre (fifty centimètres), and so

on. The box of trial glasses contains convex and concave spherical and cylindrical lenses; (the sign + signifies a convex lens, the sign − a concave lens), a set of prisms, opaque discs, discs perforated by slits or small circular openings, lens holders or trial frames, and discs or slips of coloured glass. The box can be obtained from any good optician.

The following table shows the number in dioptries together with the focal lengths in centimètres and Paris inches of the trial lenses in use, and the approximate number in the old system.

DIOPTRIES.	FOCUS IN CENTIMETRES.	FOCUS IN PARIS INCHES.*	NUMBER IN OLD SYSTEM.*
0·25	400	148	
0·50	200	74	72
0·75	133	49	48
1·	100	37	36
1·25	80	29·6	30
1·5	66	24·5	24
1·75	57	21	20
2·	50	18·5	18
2·25	44	16·4	16
2·5	40	15	15
2·75	36	14	14
3·	33	12·3	13
3·50	28	10·5	11
4·	25	9·25	9
4·50	22	8·22	8
5·	20	7·4	7
5·50	18	6·74	—
6·	16	6·14	6
7·	14	5·29	5
8·	12	4·6	4½
9·	11	4·11	4
10	10	3·7	—
11	9	3·37	3½
12	8·3	3·07	—

DIOPTRIES.	FOCUS IN CENTIMETRES.	FOCUS IN PARIS INCHES.*	NUMBERS IN OLD SYSTEM.*
13	7·6	2·84	3
14	7·1	2·63	—
15	6·6	2·48	$2\frac{1}{4}$
16	6·2	2·29	—
17	5·9	2·18	—
18	5·5	2·	2
20	5	1·75	

* A Paris incb = $1\frac{1}{8}$ English inch.

* In this column tbe numbers signify the focal length in Paris inches of the respective lenses contained in the old boxes.

CHAPTER II.

Examination of the Eyeball and its Appendages.

The examination of the eyeball and its appendages will be considered under four heads :—

1. By the unaided eye.
2. By lateral illumination.
3. By the ophthalmoscope.
   (*a*) Direct ; (*b*) Indirect examination.
4. By manipulation.

The acuteness of vision, field of vision, range of accommodation, colour sense, movements of the eyeball, and its refraction, have also to be tested.

I. Examination by the unaided Eye.

In order to examine the outer surface of the eyelids, ocular conjunctiva, cornea, anterior portion of sclerotic, aqueous chamber, iris, and lachrymal apparatus, it is necessary to place the patient before a window and direct him at first to close the eyes, then to open them widely and look by turns in different directions. The reflection of the window from the cornea should be carefully watched, as the eye is moved; if any slight opacity or irregularity be present the image will be lost or become broken or distorted in some portions.

To examine the palpebral conjunctiva, it is necessary to evert the upper lid and draw the lower lid downwards. Eversion of the upper lid can be accomplished thus :—The surgeon, standing in front of the patient, should direct him to look downwards and close the eyes ; he should then place the fore-finger of one hand

upon the lid at the attached or upper border of the tarsal cartilage, and make gentle pressure downwards and backwards, so as to make the free edge of the lid stand away from the globe; then place his thumb beneath the margin of the lid and make a slight upward movement, at the same time continuing the pressure with the finger; by this means the lid will be made to turn upon itself and become everted. The lid may also be everted by pressing a probe horizontally upon its outer surface and drawing its margin upwards by the lashes, at the same time making pressure downwards with the probe.

To examine the conjunctiva covering the lower lid, all that is necessary is to place the finger upon its margin and draw it strongly downwards, when its conjunctival surface will become exposed.

Normal Appearances.

The outer surface of the eyelids is covered by soft delicate skin, which is thrown into folds on every contraction of the orbicularis muscle; their free margins are of considerable thickness. From the outer edge of this free margin project the lashes in two or three rows, those of the upper lid being thicker and longer than those of the lower. The lashes extend along the whole outer edge of each lid, but are much fewer and more delicate in that portion extending from the tear punctum to the inner canthus. The inner edge of each margin is occupied by the orifices of the Meibomian glands, which are seen as a close set of yellowish points, and extending from them the glands themselves can be seen as a row of closely set yellowish lines beneath the palpebral conjunctiva.

The ocular conjunctiva is smooth, moist, shining, and

transparent, allowing the white sclerotic to show plainly through it. A few small vessels may be seen running from the outer and inner canthi towards the cornea. The caruncle and semilunar fold occupy the space immediately external to the inner canthus, the former appearing as a small reddish-grey projection, the latter as a well-defined pinkish fold. The palpebral conjunctiva is also smooth, moist, shining, and transparent, and appears yellowish in colour, from the tarsal cartilage, to which it is closely and evenly united, showing through it. The portion of conjunctiva reflected from the lids to the globe (Fornix) appears somewhat thickened and wrinkled, and is slightly more vascular than the ocular and palpebral portions.

Certain parts of the conjunctiva require to be specially examined; next the thickened margin of the lid, in the fornix or about the caruncle are the most frequent situations for the lodgment of a foreign body. The portion covering the attached border of the tarsal cartilage of the upper lid should also be noticed, as it is here that granular ophthalmia manifests itself most plainly.

The cornea is smooth, shining, and perfectly transparent throughout, except in the case of old persons in whom a bluish-white rim (arcus senilis)* is often seen occupying more or less of the structure somewhat within its margin; no blood-vessels are seen on its surface or in its substance. The anterior portion of the sclerotic is pearly-white or of a pale blue tint and shining. It is plainly visible, through the transparent conjunctiva covering it; some fine vascular twigs are seen passing forwards from the equator to a point about $\frac{1}{8}$ of an inch from the corneal margin, where they end abruptly.

It is necessary that the blood-vessels seen upon the

* The same condition occasionally occurs in quite young people.

anterior surface of the eyeball should be carefully noticed, for although but insignificant in health, they become greatly enlarged, and their visible number enormously increased in inflammation; and their position and size are important aids in the differential diagnosis of inflammation of the eyeball. The diagram

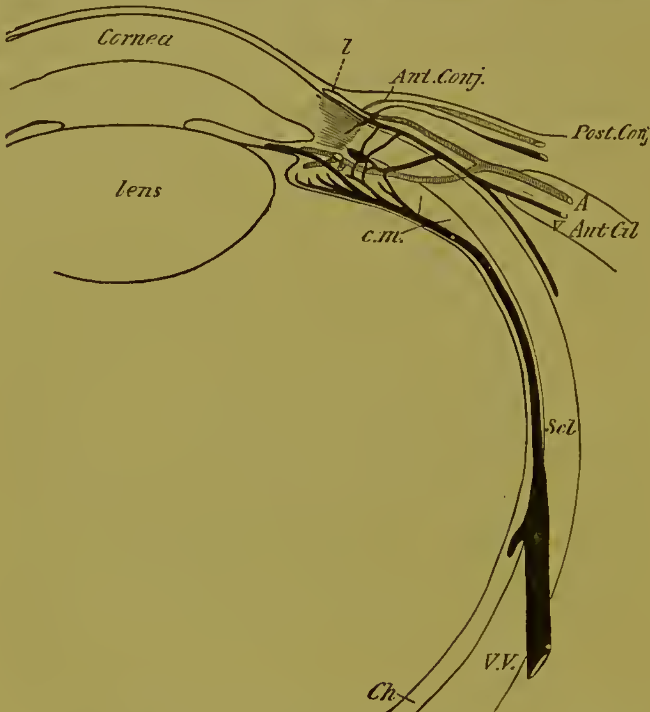

FIG. 16.—Vessels of the front of the eyeball. *c.m.* Ciliary muscle. *Ch.* Choroid. *Scl.* Sclerotic. *V.V.* Vena vorticosa. *l.* Marginal loop-plexus of cornea. *Ant.* and *Post. Conj.* Anterior aad posterior conjunctival vessels. *Ant. Cil. A.* and *V.* Anterior ciliary arteries and veins. (Simplified and altered from Leber). (After Nettleship).*

(Fig. 16) shows the vascular system of the anterior portion of the eyeball.

* The Figs. 16, 17, 18 and 19, are taken from Nettleship, "Student's Guide to Diseases of the Eye."

In disease three different sets of vessels become congested.

1. The vessels supplying the conjuctiva only (posterior conjunctival vessels), (Figs. 16, 17).

2. The anterior ciliary vessels lying in the episcleral tissue beneath the conjunctiva, the perforating branches of which, are the vessels already mentioned as seen in health, terminating abruptly at a short distance from

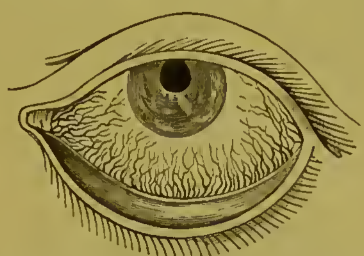

FIG. 17.—Conjunctival congestion (engorgement of the posterior conjunctival arteries and veins). (After Guthrie).

FIG. 18.—Congestion of the perforating branches of the anterior ciliary arteries. (Dalrymple).

the corneal margin (Figs. 16, 18). Their non-perforating branches (Figs. 16, 19) lie in the episcleral tissue, and extend up to the corneal margin. In health they are invisible, but when distended they form a pink zone of fine straight vessels around the cornea, *circumcorneal zone or ciliary injection.*

3. The vessels of the corneal margin *and* anterior portion of conjunctiva (the anterior conjunctival vessels and their loop plexus on the corneal margin, Fig. 16). These are branches of the anterior ciliary vessels and join with the post-conjunctival vessels.

A bright red network of vessels which move with the conjunctiva, when it is slid over the globe, most distinct towards the equator and least so near the cornea (Fig. 17) shows congestion of the posterior conjunctival vessels, and indicates inflammation of the conjunctiva (ophthalmia). A pink zone around the cornea, made

FIG. 19.—"Ciliary congestion" (engorgement of episcleral twigs of anterior ciliary arteries). (After Dalrymple).

up of straight vessels radiating from the cornea, and not moving with the conjunctiva, shows congestion of the anterior ciliary vessels (Fig. 19) and means iritis or corneitis. Congestion in the same zone deeply seated, of a lilac tint, and rather patchy, indicates inflammation of the ciliary body (cyclitis). A dusky red patch on one side of the eyeball, rather external to the ciliary region, means inflammation of the episcleral tissue (episcleritis). A superficially situated bright red zone of vessels around the cornea, often encroaching on it, shows congestion of the anterior conjunctival vessels and their loop plexus (Fig. 16) and indicates severe superficial inflammation or ulceration of the cornea.

Distension of the vessels seen in health to terminate near the corneal margin (perforating branches of anterior ciliary arteries, Figs. 16, 18, and their accompanying veins) with a scanty zone of dusky colour around the cornea as a rule indicates glaucoma.

The aqueous chamber is filled by the aqueous humour, which is transparent, colourless, and of such quantity as to preserve the proper curvature of the cornea, without causing tension, or allowing of laxity, and to keep it separated from the iris by a considerable interval.

The iris varies in colour in different individuals and occasionally in the two eyes of the same person; it is often irregularly pigmented so that parts of it in the same eye are lighter or darker than the remainder. Its surface is bright and shining, slightly ridged and furrowed especially in a radiating direction around the pupil; these points should be carefully noticed as loss of polish and a certain uniformity of surface, are among the earliest symptoms of inflammation.

The pupil lies somewhat to the inner side of the centre of the iris. Its mobility, size in ordinary daylight, and shape have to be noticed. The two pupils must be examined separately and together. The simplest and also the best way of examining the pupil is to direct the patient to look out at the window, and then alternately shade and uncover the eye with the hand or some opaque object. In health, if one eye alone is shaded, its pupil should dilate considerably when shaded, and contract quickly on exposure to light—direct reflex action; during the trial, the pupil of the other eye will act, but to a less extent—indirect reflex action. The pupil also contracts when the eye is accommodated for its near point, *i.e.*, when an object about five or six inches away is looked at, and dilates again when the accommodation

is relaxed and a distant object regarded. This associated action, however, is not so great as the reflex action; but it must be remembered when examining the reflex action, as some patients persist in accommodating for the hand when the eye is shaded and consequently the pupil contracts nearly as much when the eye is covered as when it is exposed to light.

The movements of the pupils vary in different individuals, and become more sluggish as age advances. The usual size of the pupil also varies considerably; it is larger in myopia, than in emmetropia and hypermetropia, also in delicate anæmic persons than in the healthy and robust; it is smaller in old persons than in the young. It should be quite round in health.

The direct reflex action of the pupils is lost in blind eyes, if however, one eye see well, the indirect reflex action is present in the other eye, even if quite blind, provided the nerve supply of the iris is healthy. The pupil will not act in cases of recent iritis or of extensive old iritic adhesions, in cases where the structure of the iris has become much altered by disease, and in cases of paralysis of its nerves. In cases of locomotor ataxy and some other spinal affections with no failure of sight, the reflex action of the pupils is lost, though they act well during accommodation—associated action; the condition is often described as the "Argyll Robertson pupil." The action of the pupil is destroyed or greatly restricted by mydriatics and myotics.

The examination of the lachrymal apparatus gives chiefly negative results; the position of the tear puncta closely in contact with the ocular conjunctiva must be noticed, pressure with the finger over the lachrymal sac causes no escape of fluid through the puncta, neither can the lachrymal gland be felt or seen in a normal condition of the parts.

II. Examination by Lateral or Focal Illumination.

All the parts mentioned above are more plainly seen by lateral illumination than by the unaided eye; minute foreign bodies, slight opacities of the cornea, etc., which might be overlooked in the previous examination are discovered, and in addition the whole of the lens and the anterior portion of the vitreous can most satisfactorily be looked into.

The examination should be conducted as follows:— The patient should be seated in a dark room (the pupil

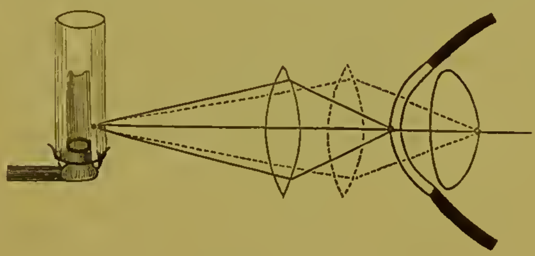

Fig. 20.—Lateral Illumination.

may be previously dilated with atropine or homatropine if necessary) and a lamp placed at about two feet distance on the left, and rather in front of his face. The surgeon should stand nearly in front, or rather to the patient's right side, and facing him; he should then take in his right hand a biconvex lens of about two and a half inches focal length,* and with it concentrate the light from the lamp on the surface of the cornea; with a little manœuvring he will find that he can throw the light through the pupil to a considerable depth into the eye, as shown by the continuous and broken lines in the diagram Fig. 20 The patient should be told to look in

* A lens of two and a half inches focal length is about equal to one of fifteen dioptrics in the metrical system.

various directions, so that all parts of the anterior portion of the eye may be examined.

Lateral illumination gives chiefly negative results. The lens in health is perfectly transparent, and in youth is nearly colourless, but some bluish lines showing its division into different segments can be recognised by careful examination. As age advances, these lines become more marked, and the whole lens appears of a bluish-grey colour, though its transparency is still unaffected.

Beyond the lens all appears dark, but any hæmorrhage occupying the anterior part of the vitreous, or a tumour coming forwards from the deeper parts of the fundus and extending to the back of the lens, or growing from the ciliary region would be discovered.

It should be noticed in the examination by lateral illumination that opacities of the cornea, etc., always appear with greatest distinctness on the side which is furthest from the light. A second lens may also be used to magnify the parts illuminated by means of the first.

III. Examination by the Ophthalmoscope.

Description of the instrument.—The ophthalmoscope consists essentially of a mirror of silvered glass or polished metal, having a central opening, with certain accessory portions in the shape of convex lenses of different foci, used as objective lenses; clips and other contrivances for holding ocular lenses behind the sight hole of the ophthalmoscope, together with the ocular lenses themselves. The ophthalmoscope since its introduction has undergone innumerable modifications, both

in principle and detail; the number of different instruments now in use being nearly, or quite, as great as that of ophthalmic surgeons.

A useful form of ophthalmoscope is that of Liebreich, the latest modification (Fig. 21) of which consists of a silvered glass concave mirror of about twenty centimetres focal length, having a central opening in the silvering of three millimetres diameter. The mirror is fixed in a metal back, with a central perforation about double the diameter of the opening in the silvering. Upon the metal back is fixed a clip for the purpose of holding an ocular lens; the back is screwed to

FIG 21.—Liebreich's Ophthalmoscope (from Bryant).

a handle about two and a quarter inches long. The accessory portions consist of two object lenses of two and a half and three inches focal length respectively,* and five ocular lenses—two convex, of six and twelve inches positive foci;† and three concave, of eight, twelve and twenty-four inches negative foci;‡ all made to fit

* Fifteen and thirteen dioptrics, metrical system.

† About six and three dioptrics, convex.

‡ About 4·5, 3, and 1·5, dioptrics, concave.

into the above mentioned clip. A very convenient case contains the whole.

Method of using the ophthalmoscope.—There are two methods of using this instrument. The first, which requires much practice, with the ophthalmoscope alone, without the aid of a biconvex object lens, is called the direct method of examination, or examination of the *erect image.*

The second, which is much the easier of the two, is called the indirect method, or examination of the *inverted image;* in it both the ophthalmoscope and a biconvex lens are used.

Direct ophthalmoscopic examination.—In this method a virtual erect image situated behind the eye is seen. The examination is conducted in the following manner:—

The patient being seated in a dark room, a gas or other lamp (gas being preferable) should be placed at the side corresponding to the examined eye, on a level with it, but so situated as to leave the cornea in shade: he should then be directed to look forwards and a little upwards, at some distant object, and to keep the eyes as steady as possible.

Supposing the right eye to be examined, the lamp should be placed at the patient's right side; the observer, standing in front, a distance of eighteen inches or two feet, separating his eye from that under examination, should take the ophthalmoscope in his right hand, look through the sight hole with the right eye, and reflect the light from the lamp through the pupil of the patient's right eye. If the examination be conducted properly, the pupil will appear of a bright red colour. The observer should then look for the optic disc, which is situated rather to the inner side of the axis of the eyeball; he will know that the disc is in view from the alteration

in colour of the pupil, which will turn from red to white, or pinkish white. Having obtained the peculiar reflection of the optic disc, the observer (taking care to relax

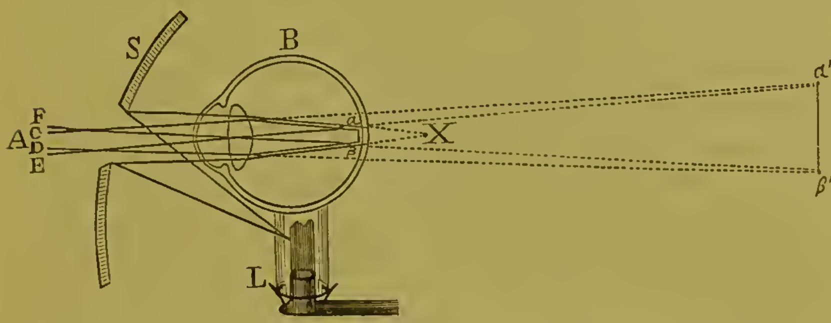

FIG. 22.—A, position of observer's eye; B, observed eye; S, the mirror; L, the light. The thick continuous lines show the course of rays from the light to the mirror and reflected from it, forming a slightly divergent pencil, which would after refraction be focussed at X, and consequently illuminates the fundus with diffuse light. $\alpha\ \beta$ is the illuminated portion of the fundus (object); the continuous lines α E and β F are the secondary axes drawn to the extremities of the object $\alpha\beta$, and two returning rays α C, β D, which after refraction diverge from their respective secondary axes; but their continuations in the opposite direction meet the secondary axes as shown by the broken lines, in the points $\alpha'\beta'$, which are the virtual foci of the points $\alpha\ \beta$, and between which the magnified, erect, virtual, image of $\alpha\ \beta$ is formed and seen by the eye placed at A.

The foregoing explanation is correct only when the illuminated portion of the fundus (object) lies somewhat within the principal focus of the "dioptric system," in other words when the eye is hypermetropic.

If the object be situated *exactly* at the principal focus of the dioptric system the rays represented by the lines, α C, and β D, will after emerging from the eye be parallel to the respective secondary axes, α E and β F, and if prolonged in the opposite direction will continue parallel to and nowhere meet the same axes.

Theoretically, therefore, no image of the object $\alpha\beta$ is formed; or what comes to the same thing it is formed at "infinity;" nevertheless a distinct, virtual, erect and highly magnified image of $\alpha\beta$ can be easily seen, provided the observed eye be approached within two inches.

his own accommodation) should approach the eye until an interval of only two inches separates his cornea from that of the examined eye. Some difficulty will be experienced in keeping the eye illuminated, increasing as the distance between the observed and the observer becomes less; this, however, will be overcome by practice. When the observed eye has been approached to within a distance of two to three inches (supposing both the examining and examined eye to be emmetropic), a distinct erect and greatly magnified image of the parts occupying the fundus of the latter should be obtained; most observers will, however, find the image sharpened in outline and detail by using a weak *concave* lens behind the sight-hole of the ophthalmoscope. Should either the observer or patient be myopic, it will be found necessary, in order to examine the erect image, to place behind the sight-hole of the ophthalmoscope a concave lens, which neutralises the existing ametropia, because if the patient be myopic the returning rays are convergent and cannot be focussed on the retina of an observer whose eyes are emmetropic until rendered parallel, or in one who is myopic whether the patient be myopic or not until rendered sufficiently divergent.

The examination of the erect image, although requiring considerably more practice than that of the inverted, should never be neglected, as it gives much more satisfactory evidence of minute changes in the fundus oculi, all the parts being seen highly magnified (about 14½ times). It gives, however, a less extensive field of vision, on account of the size of the objects, which only allows small portions of them to be seen through the pupil at one time.

The optic disc, retinal vessels, and other parts occupying the fundus, should be examined by looking in different directions through the pupil; the observed eye

being kept steadily fixed during the examination upon some distant and suitably situated object.

The right eye having been examined, the lamp should be placed on the patient's left side, and the manœuvre repeated; the observer using the left hand and left eye, instead of the right hand and right eye. The condition of refraction of the eye can be diagnosed by the direct method of examination. (See p. 56).

Indirect ophthalmoscopic examination.—In this method of examination a "real" inverted (see Fig. 13, p. 12) aerial image of the fundus oculi is formed by the interposition of a biconvex lens between the observer and the observed eye.

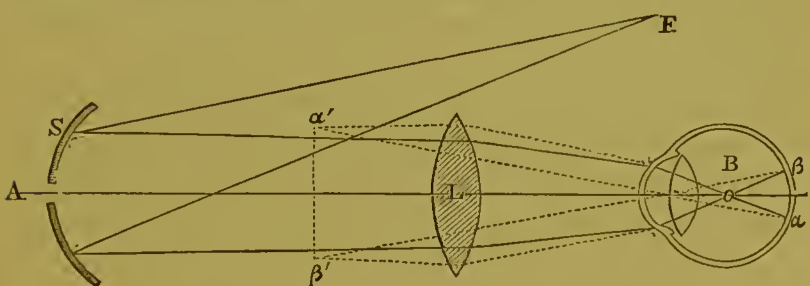

FIG. 23. From Carter's translation of "Zander on the Ophthalmoscope;" A, observer's, B, observed eye; F, the light; S, the mirror; L, the biconvex lens; $\alpha\ \beta$, some portion of the retina, or the disc; $\alpha'\ \beta'$, its inverted aerial image formed between the mirror and biconvex lens.

The position of the patient and observer should be the same as for the direct examination; the same lamp also can be used, but should be placed rather further back and may be kept on one side during the examination of either eye. The ophthalmoscope should be held in the same manner and the light reflected through the pupil as detailed above; but the red reflection having been obtained, the observer must not approach the eye, nearer than about eighteen inches.

The patient should be directed to look at some distant

object so situated that the axis of the observed eye is turned somewhat inwards; this brings the optic disc (which lies somewhat to the inner side of the optic axis) opposite the ophthalmoscope, and its peculiar bright reflection will be at once observed.

The biconvex lens should then be held in front of the observed eye at a distance about equal to its own focal length from the cornea, and steadied by the observer resting his ring and little fingers on the patient's brow. By this means an inverted image of the optic disc and vessels of the retina is immediately seen, which, although apparently within the eye, is in reality formed in the air between the observer and the biconvex lens, and (in emmetropia) at a distance from the latter corresponding to its focal length.

If the image of the disc appear indistinct, the observer may be sure that his own eye is not accommodated for the distance at which the image is situated, which is, in reality, shorter by some inches than it appears to be. Should this be the case, the observer must increase the tension of his accommodation, or withdraw somewhat further from the observed eye.

A better method, however, than either of the foregoing, is to employ habitually, behind the sight hole of the ophthalmoscope, a convex ocular lens of about ten or twelve inches* focal length. If this is done, a clear and well-defined image will always be obtained without tension of accommodation, provided precautions are taken that the distance between the observer's eye and the image is *not greater than the focal length of the convex ocular lens.*

The disc and parts immediately surrounding having been examined, the patient should be directed to look straight forward, so as to bring the region of the yellow spot opposite the ophthalmoscope; this having been

* Four or three dioptrics.

carefully examined, the eye should be turned upwards, downwards, to the right and left, so that all parts of the fundus may be examined in turn.

In the indirect method of examination the observer should use his right eye, and hold the ophthalmoscope in his right hand and the biconvex lens in his left in examination of the right eye, and *vice versâ* in examination of the left.

Difficulties of Ophthalmoscopic Examination.

The use of the ophthalmoscope is not so easily learned as might at first appear, and proficiency is only arrived at by long and patient practice; the beginner will be frequently much disheartened at his want of success. Some of the difficulties are only to be overcome by practice, others are easily remedied. Reflections of the mirror from the two surfaces of the object lens often prove very troublesome; the inconvenience arising from this source is obviated by holding the lens somewhat obliquely, when the two images will recede from each other and leave a clear space between them. Reflection from the surface of the cornea may be troublesome, but can usually be overcome by a little manœuvring. Contraction of the pupil is also an insurmountable obstacle to the beginner, but can be removed by dilatation with atropine; for this purpose a solution of one grain to one ounce of water should be dropped into the eye about half an hour before the examination is made; or the patient may be ordered to use a solution of one-eighth grain to one ounce two or three times on the day preceding it. A solution of hydrobromate of homatropine may be used for the same purpose, its effects pass off sooner than those of atropine. When experience has been gained, however, mydriatics can be dispensed

with, except in some few cases, or in those where it is necessary to make a very careful examination by lateral illumination.

If the patient be directed to look at a distant object the accommodation is relaxed, and sufficient increase in the pupillary area will generally take place.*

Every ophthalmoscopic examination should be conducted on a certain definite system.

The first step should be to examine the condition of the refractive media by lateral illumination.

Next, the condition of refraction of the eye, and the state of the vitreous chamber should be ascertained by the direct method of examination. (See p. 56).

Thirdly, a general survey of the fundus oculi should be made by the indirect method.

And fourthly, any abnormalities having been discovered by the indirect examination should be fully and carefully studied in detail by the direct method.

If this systematic plan of examination be carefully carried out few mistakes will be made, and no abnormality of importance is likely to be overlooked.

Normal Appearance of Parts seen by the Ophthalmoscope.

The refractive media (cornea, aqueous humour, lens, and vitreous), as stated under Lateral Illumination, are perfectly transparent.

The retina is either quite transparent and colourless, or in dark eyes may appear as a faintly grey-cloud, covering the choroid; its position is marked by that of its blood-vessels. The bright red reflection pre-

* It is a common practice to direct the patient to look at the little finger of the hand with which the observer holds the ophthalmoscope. This is a mistake as the patient immediately accommodates for the finger and his pupil contracts.

viously mentioned is due to the blood in the choroid; the depth in colour of the reflection varies with the amount of pigmentation of this vascular tunic—in blue or grey eyes it is light red, in dark ones of a much deeper tint, and in the negro appears to be dusky blue or slate colour. The parts of the fundus oculi requiring special attention are the optic disc and parts immediately surrounding it, and the region of the yellow spot.

The disc appears at first sight to be of an uniform pale pink colour, but on closer examination different portions are found to present different shades.

Its centre is pale, or even white; next to this succeeds a zone of pink, this being again bounded by an apparently double border of lighter colour. The pale appearance of the central portion of the disc is caused by connective tissue surrounding the blood vessels in this situation. The succeeding pink zone consists entirely of nerve-fibres and delicate capillaries. The outer pale double border is formed by the margins of the sclerotic and choroidal rings, which do not accurately cover each other, the choroidal ring being somewhat greater in diameter than the sclerotic opening, the margin of which, being left uncovered by pigment, shines through the transparent nerve-fibres.

Both the white central portion and the outer ring are in some cases so distinctly marked, that the appearance produced might be taken by an inexperienced observer as evidence of disease, but both conditions are perfectly consistent with health. From the pale central portion of the disc proceed the retinal blood vessels; these appear upon its surface usually at the same point, but may emerge separately or in groups of two or three, or a branch may appear coming from beneath the choroid at the margin of the disc.

As a rule about eight vessels are seen, upon or close

to the disc, four of these being arteries, with a corresponding number of veins ; two of each pass upwards and a like number downwards, to be distributed over the retina. The lateral branches are comparatively insignificant, and are given off from the principal trunks, either upon the nerve-surface or in the retina near its margin.

The veins are distinguished from the arteries by being of greater calibre, the proportion being about three to two. There is also a difference in colour between the two, the veins being the darker; the arteries are marked by a double contour, and their central portion is much lighter than their borders.

Occasionally a dark spot is noticed in one of the vessels at its origin or termination in the disc. This might be taken for a clot, but the appearance is caused by a peculiar arrangement of the vessel, which at this point is seen, as it were, on end and foreshortened.

Spontaneous pulsation of some of the retinal *veins* may also be observed; the occurrence of *venous* pulsation is, however, perfectly consistent with health, and has no pathological import.

In any eye, pulsation, both arterial and venous, can be produced by pressure upon the globe, but should it occur spontaneously in the *arteries*, it shows increase of tension, and has the gravest significance. (*See* Glaucoma). Arterial pulsation may, however, occur spontaneously in cases of aortic regurgitation, but so far as the eye is concerned need cause no anxiety.

Anomalies of Optic Disc, etc., consistent with Health.

Certain phenomena are not unfrequently observed with the ophthalmoscope, which, although contrary to

the condition usually met with, are perfectly consistent with a normal state of the parts.

The appearances caused by the connective tissue surrounding the central vessels, the occurrence of pulsation, unusual distribution, and existence of dark spots in the latter, together with the unusual distinctness of the sclerotic ring, have been already mentioned.

Other anomalies are—

1. **A dark crescentic figure** bordering some portion of the margin of the disc. This appearance is caused by a peculiar arrangement of the choroidal pigment; it is congenital.

2. **Variations in depth of colour of the disc** are frequently met with. Due regard must be had to the colour of the surrounding fundus in forming an opinion as to whether the tint in any particular case is so much deepened or lessened as to constitute a diseased condition.

In light eyes the disc appears much redder than in dark, the apparent difference being due more to contrast with the surrounding parts than to actual change in colour.

Slight deviations are only to be determined by careful examination and long experience.

3. **Excavation of the optic disc.**—Not unfrequently a sloping or even abrupt depression is met with occupying the centre of the disc, but usually extending somewhat further towards the yellow spot than in other directions. The whole nerve-surface, however, is never included in the cup; the vessels do not bend under its edge, their calibre is not altered, neither is spontaneous arterial pulsation observed, as may be the case in the excavation of glaucoma. (*See* Glaucoma).

4. **Persistence of the hyaloid artery.**—Occasionally a small whitish cord may be seen extending from

the centre of the disc to the back of the lens; it is the remains of a vessel which, during fœtal life, nourished the latter structure.

5. **Shot silk appearance.**—A peculiar glistening watery appearance of the retina, most marked along the borders of the larger blood-vessels, has been called attention to by Mr. Spencer Watson. The name "shot-silk appearance" which he has applied to it describes it perfectly; it is seen most frequently in children. A very similar appearance may be caused by the patient's hair intervening between the mirror and the lamp and causing the light to be reflected in an irregular manner.

6. **Senile changes.**—As age advances, the refractive media become less transparent, the retina grows somewhat hazy and the disc appears whiter than in youth.

7. **An appearance of white whisp-like patches,** extending from some part of the margin of the disc over the surrounding fundus. These patches have irregular jagged borders, and are often of considerable size; the retinal vessels pass through and are obscured by them, and occasionally white threads are continued for some distance along the sides of the vessels.

The patches are caused by the opaque nerve-sheaths which should end at the lamina cribrosa, being accidentally continued beyond this point into the transparent retina; they are congenital, and do not interefere with vision.

8. **The choroidal vessels** are at times (especially in light eyes) very plainly visible appearing as an irregular net-work of pale pink bands.

The region of the yellow spot presents in health no very marked ophthalmoscopic signs, but requires special notice, as it is frequently the seat of pathological lesions. In the normal condition it is marked by the absence of blood-vessels, which appear to avoid this part of the retina passing above and below it; some deepening

in colour, and occasionally an indistinct, dark, transversely oval figure, in some cases having a bright centre, or surrounded by a shining, but rather ill-defined ring can be detected.

Examination by Manipulation.

The fourth method of examination, *by manipulation*, consists simply in ascertaining the tension of the globe by digital pressure. The examination should be conducted as follows:—The patient being directed to look downwards and close the eye gently, but not to screw up the lids, the surgeon should make gentle alternate pressure with the fore or middle finger of each hand placed upon the closed upper lid; the pressure should be made in a direction downwards and backwards so as to compress the globe against the floor of the orbit.

In health the eyeball is firm, tense, and semifluctuating; in disease the tension may deviate in the direction of increase or decrease. The degree of tension may be expressed as follows:—If normal as Tn, if above par as T+1, T+2, T+3, according to the amount of increase; if below par as T—1, T—2, T—3. If a doubt exist as T+? or T—? according as the doubt is on the side of increase or decrease.

Acuteness of Vision (V).

When we speak of the acuteness of vision we refer to the perceptive and conductive power of the nervous structures concerned in sight. The optical conditions necessary for normal vision have been given at p. 15.

In order to ascertain the acuteness of vision, we use "test-types," which are letters made of certain definite proportions, and which can be recognised by a standard eye at certain distances.

The test-types of Dr. Snellen* are those most gener-

* Snellen's types can be obtained from Messrs. Williams and Norgate, Henrietta Street, Covent Garden.

ally used. Each set of letters should be recognised at a distance corresponding to the number marked over each. In the earlier editions of the book the distances were marked in feet, but now the metrical system has been adopted, and the size of some of the letters altered. Besides letters the book contains a fan of lines for testing astigmatism, coloured letters for testing colour senses, figures for testing persons who cannot read, dots of different sizes and lines of various breadths. There is some variation of objects in different editions of the book.

The distances are so arranged that the letters or other objects present themselves at an angle of 5 minutes, which is the smallest visual angle under which a standard eye can recognise objects distinctly, see p. 16. We can express the acuteness of vision by the formula $V = \frac{d}{D}$, in which D = the distance at which the letters are presented under an angle of 5 minutes, and can be recognised by a standard eye, *d* the distance at which they are recognised by the eye under examination. If D and *d* be equal, *e.g.*, if 6 can be read at 6 m, $V = \frac{6}{6} = 1$, *i.e.*, normal acuteness of vision is present; but if 6 can be made out only at 3 m. or 1 m., then $V = \frac{3}{6} = \frac{1}{2}$, or $\frac{1}{6} = \frac{1}{6}$.

We shall, however, in practice find it more convenient to alter the formula thus:—Let $d = 6$ m. in all cases, and D the number of the letters that can be made out at that distance. Suppose that 6 can be read at 6 m. the formula will be $\frac{6}{6} = 1$, as in the previous case; but if 6 cannot be made out, we may ascertain what letters can be read, and place the number of these for D, *e.g.*, 12 can be read at 6 m. we write $V = \frac{6}{12} = \frac{1}{2}$, or if 36

only can be made out at 6 m. we write $V = \frac{6}{36} = \frac{1}{6}$, and so obtain the same results as before without the necessity of altering our patient's position.

In testing the acuteness of vision we must be careful to ascertain the same value for all the different types, *i.e.*, all should be recognised at their proper distances— ·5 at 50 cm., ·6 at 60 cm., 6 at 6 m., etc.

If in any case we find that the small types, *e.g.*, ·5 at 50 cm., can be read easily, while more distant ones cannot be made out, or that the distant ones can be seen clearly, while those at short distances cannot be read, we may at once assume that we are dealing with some anomaly of refraction, and we shall probably find on correcting this by suitable glasses that the proper values will be obtained for all the types. Prefectly normal acuteness of vision may exist with very considerable ametropia. The test types of Dr. E. Jaeger are perhaps more frequently used than those of Snellen for reading in the hand; they are equally good for this purpose, but should not be used for greater distances than eighteen inches or two feet. The numbers over them correspond to the number of feet at which they should be read, thus, 1 should be read at 1 foot, 2 at 2 feet, and so on.

The acuteness of vision is considerably modified by age, being above the standard in youth, and often much below it in old age.

The failure in the latter is due to natural senile changes, as loss of transparency of the media, or degenerative changes in the nervous structures concerned in vision. Such changes can hardly be looked upon as morbid, and we should expect to find them in all old people.

In any case in which we find abnormal want of sight

we may always attribute the failure to some of the following causes; opacity of the media, anomalies of refraction or accommodation; and those affections of the retina, choroid, optic nerve and brain, which were formerly classed together under the names "amblyopia" and "amaurosis."

Field of Vision.

By the field of vision we understand the area over which objects can be distinguished, whilst the eye is kept fixed on some one point. The limits of the field of vision are marked by the most eccentrically placed points of objects, which can still be distinguished, the direction of the visual line being unaltered.

The extent of the visual field may be roughly measured by one of the two following methods:—

1. Having placed our patient in a convenient position, we stand opposite to him, at a distance of about two feet, and supposing his left eye to be examined, direct him to look steadily at our own right eye, which is opposite to his left, the patient's right eye and our own left being kept closed. We then move the hand in various directions in the peripheral parts of the field, and notice if its movements are perceived by the patient at the same distance from the centre as by our own presumably healthy retina. We must take care that the hand is moved in a vertical plain, situated midway between our own eye and that of the patient, and not nearer one than the other; and also see that the patient keeps his eye fixed.

Supposing that the eye under examination distinguishes all movements of the hand at the same distance from the centre as our own, we decide that the field of

vision is normal; but if a falling-off is noticed in any particular direction, we infer that the sensibility of the corresponding portion of retina is impaired.

It must be remembered that each part of the visual field corresponds to a part of the retina opposite to and not on the same side as the object seen—*e.g.*, suppose that the movements of the hand are not perceived in the outer half of the field, the inner half of the retina is defective, and *vice versâ.*

It must also be borne in mind that the height of the bridge of the nose has a considerable influence in limiting the inner half of the visual field.

2. We place our patient at a distance of twelve inches from a black board about two feet square, having a white cross in its centre, and direct him to look steadily at the cross, which must be situated on a level with the eyes. One eye being closed, we test the sensibility of the retina of the other, thus: we move a piece of chalk, fixed on a dark handle, from all directions towards the cross, and mark at the point at which the chalk first becomes visible.

The portion of the visual field limited eccentrically by a line joining the points at which the chalk is first seen when approaching from every direction is known as the *quantitative field of vision,* in contradistinction to an area bounded excentrically by much narrower limits, over which objects are distinctly defined and letters can be read, known as the *qualitative field of vision.*

This method of examination is sufficiently accurate if the boundary of the visual field do not extend to more than 45° from the fixation point in any direction; but beyond that angle the object on a flat surface will be too distant from the eye to allow of accuracy. Consequently, except in cases of considerable contraction, if we require an exact field, we must employ an in-

strument known as the perimeter, which in its commonest form consists of an arc marked in degrees, and movable round a central pivot, in the centre of which is a circular white spot or other object on which the patient fixes his gaze. Fig. 24 represents the perimeter designed by Mr. Brudenell Carter. Upon the arc is a

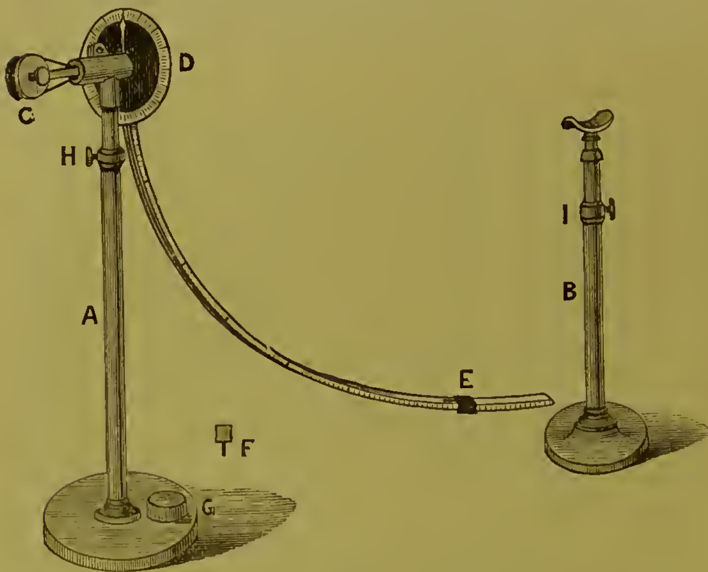

FIG. 24.—*Carter's Perimeter.* A, telescopic stand; B, chin rest; C, milled head, by turning which the clip, E, is made to slide along the arc; D, milled disc connected with the arc by a pivot in the centre of which is placed a white circular spot on which the eye is fixed. The back of the disc is marked in degrees to show the angle at which the arc is placed. The arc is moved by turning the milled disc. F, is one of the squares which are placed in the sliding clip. The perimeter is made by Mr. Hawksley of Oxford Street.

sliding clip for holding white or coloured squares of paper. The person whose field we wish to examine places his chin on the rest, closes one eye, and fixes the white central point with the other; the clip holding the paper is then moved along the arc placed in various

positions from its extremity towards the centre, and the point at which it first comes into view noted, this gives the outermost limit of the field. Its shape will be found to be somewhat oval, the long axis of the oval being situated obliquely from above downwards and outwards. The field extends from the central or fixation point outwards, 90° or more, in other directions it is limited by

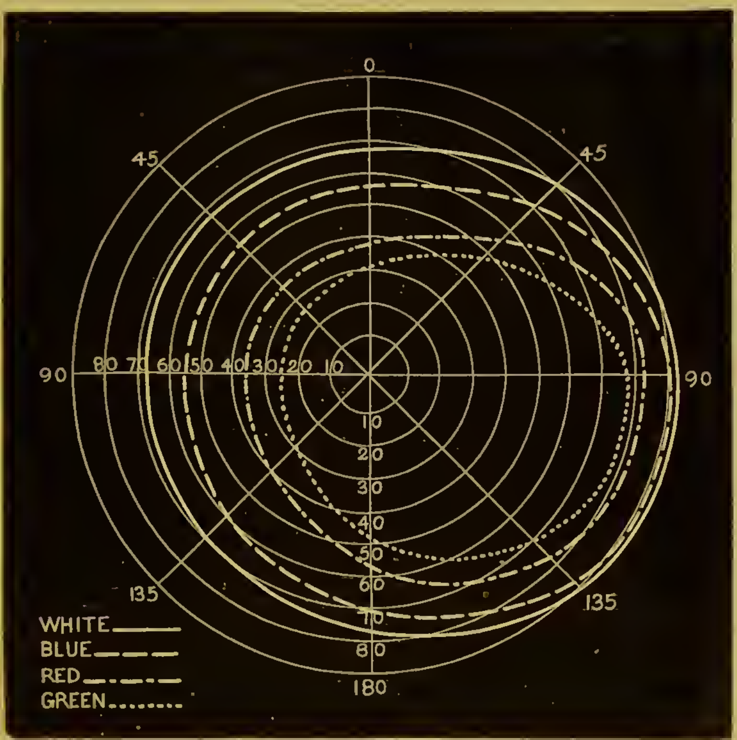

FIG. 25.—Field of vision of right eye. The continuous, broken and dotted lines show the outer limits of the field over which different colours can be recognised. (Landolt).

the height of the bridge of the nose, prominence of orbital margins, and depth of the eyeballs in the orbits, and extends for about 65° to 75° from the fixation point. The extent of field is different for different colours, white is the largest, then comes Blue, next Red, and last Green. (See Fig. 25).

Contraction of the visual field, or gaps in its area (scotomata) are very constant accompaniments of retinal or choroidal changes; contraction is also one of the earliest symptoms of glaucoma, and occurs as a physiological condition with advancing age.

Charts corresponding to Fig. 25, but without the lines indicating the field for different colours, are printed for the purpose of making a record of the field. The straight lines show the angle at which the arc is placed, the circular lines the angle from the visual line directed to the central dot.

Accommodation (A).

By accommodation is meant the power which the eye possesses of altering the condition of its refractive media, so as to form upon the retina images of near objects, the rays of light from which are divergent, equally distinct as images of more distant ones, the rays of light from which are parallel, or nearly so.

The power of accommodation depends upon the elasticity of the crystalline lens, the curvature of which can be increased to a considerable extent; the alteration of curvature is brought about by the action of a ring of inorganic muscular fibres, situated between the sclerotic and choroid, just external to the greater circumference of the iris, known as the *ciliary muscle*. The manner in which the ciliary muscle acts upon the lens is as yet a disputed point, one theory being that the lens is maintained in a flattened condition by tension of its suspensory ligament so long as the eye is adjusted for a distant object; that upon accommodation for a near one the ligament is relaxed by contraction of the muscle, and the curvature of the lens (more especially that of its anterior surface) increased by virtue of its own elas-

ticity. The other theory is that the ciliary muscle compresses the lens in some manner, and so alters its curvature.

Range of Accommodation.

We speak of the range of accommodation, and by it we mean the power of a lens, which we suppose the crystalline adds to itself when we change our look from the furthest to the nearest point of distinct vision. Thus, an eye which sees clearly at infinite distance when its accommodation is relaxed, and at 16 centimètres with greatest tension of accommodation, has a range or "amplitude" of accommodation equal to a lens of $\frac{100}{16} = 6$ D the focal length of which is 16 centimètres. (See p. 17). We test the range of accommodation by ascertaining the furthest point of distinct vision—*punctum remotum* $= r$—and then finding the nearest point at which small print can be read—*punctum proximum* $= p$. The latter recedes from the eye as age advances, and consequently the range of A decreases.

Accommodation is accompanied by convergence of the optic axes and by contraction of the pupil.

With convergence of the visual lines to a given point, accommodation for that point takes place. The two actions can, however, be partially disassociated, so that with the same convergence the accommodation can be altered to a limited extent, this is known as the *relative range of accommodation.* The space over which accommodation is available, that is the distance between r and p, is known as *the region of accommodation.*

The Colour Sense.

The colour sense is best tested by ascertaining the power of distinguishing various colours without naming them. The best test objects are skeins of wool of various

colours. A set of these has been introduced by Professor Holmgren, by whose name they are known. The examination is made by spreading the whole set of skeins in a good light and directing the person examined to pick out and place together all that appear to him alike. If the patient be colour-blind he will place together dissimilar colours, and will have no appreciation of different shades; at the end of the examination the skeins will be in a hopeless confusion.

Persons with acquired colour-blindness from atrophy of the optic nerve may arrange the same colours together, but if asked to name them will probably make mistakes. In congenital colour-blindness the confusion test without naming is sufficient.

Movements of the Eyeball.

The eyeball moves around a point which, as stated at p. 16, is situated on the axis about two-thirds of its length from the summit of the cornea. To ascertain that the movements are normal we need only to take a pen or other object, and move it in front of the eyes, upwards and downwards, and to the right and left. If both eyes follow the movements accurately, the muscular apparatus is in proper working order.

Muscæ Volitantes.

Beads, threads, flies, films, or webs floating before the eyes are often complained of, more especially in myopia. They are always seen most distinctly in bright light, or when looking upon a white surface as up at white clouds, or down at the pavement. They are known as muscæ volitantes and are due to mucous in the cornea, or very slight imperfections in the transparent media. If they cannot be seen with the ophthalmoscope their presence is of no importance; patients are often anxious about them, but may be assured that they will do no harm.

CHAPTER III.

Refraction and Astigmatism.

Definition.—By refraction of the eye we understand the power which the refractive media (cornea, humours, and lens) possess by virtue of their curvatures and densities of bringing together *parallel* rays of light, and forming them into an image at a certain spot (known as the principal focus of the refractive or dioptric system) *without the employment of any adjusting power.* (See also p. 5).

The refraction is said to be *normal* or *abnormal* according to the position of the retina with regard to the principal focus of the dioptric system. The former condition is known as *emmetropia*, the latter as *ametropia*, the terms, normal and abnormal being seldom applied.

Emmetropia. (E)—The emmetropic eye (Fig. 26 *a*) is of such a shape that when its accommodation is relaxed (see also p. 5 and 12) the retina is situated at the principal focus of the *dioptric system*, in which position a distinct inverted image of any object, *the rays of light proceeding from which are parallel,* is formed upon the layer of rods and cones.

Ametropia.—The ametropic eye differs from the emmetropic in two opposite directions; the deviations are known as *anomalies of refraction.* In the first and (in this country)* most commonly met with anomaly the retina

* It is generally believed amongst English, and is also reported by continental ophthalmologists, that in this country hypermetropia is of more frequent occurrence than myopia. It appears to me that the reverse may obtain, for we are rarely in hospital practice consulted

lies *within* the principal focus of the dioptric system; that is to say, the axis of the eyeball is too short from before backwards, and when the accommodation is at rest, images of objects, the rays of light proceeding from which are parallel, are formed behind the retina instead of in its substance. This anomaly is known as *hypermetropia*, or far sight (see Fig. 26 *b*).

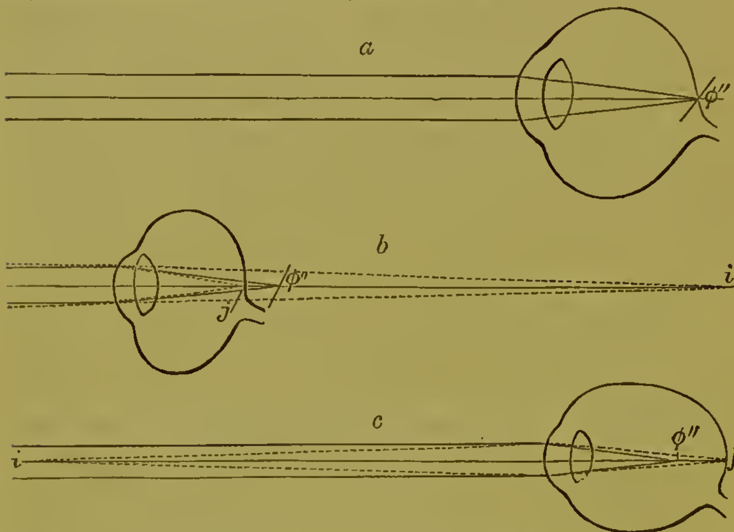

Fig. 26. From Donders', *Accommodation and Refraction of the Eye.* *a*. Emmetropia; *b*. Hypermetropia; *c*. Myopia.

To the second anomaly an opposite state of things pertains; the axis of the eyeball from before backwards is too long, consequently the retina comes to lie outside the principal focus of the dioptric system, and the image of an object, the rays of light coming from which are parallel, is formed in front of it. This anomaly is known as *myopia*, or short sight (see Fig. 26 *c*).

about slight myopia, as it gives no inconvenience. On the other hand, a very slight degree of hypermetropia may incapacitate the sempstress, skilled mechanic, or clerk, so that whereas we get all degrees of hypermetropia, we are only applied to in the higher degrees of myopia.

Fig. 26 *a* shows the emmetropic eye, a pencilof parallel rays of light is represented meeting the anterior surface of the cornea, and after refraction focussed at ϕ'' the principal focal point of the dioptric system, which is seen to be situated in the retina.

In Fig. 26 *b* parallel rays of light are shown focussed at ϕ'' which is behind the retina of the too short hypermetropic eyeball; in order that a distinct image may be formed in the layer of rods and cones (*j*) the rays of light must before meeting the cornea converge to a point *i*, as shown by the dotted lines; or the refractive power of the dioptric media must be increased; in other words A must be put on the stretch.

In Fig. 26 *c* parallel rays of light are shown focussed at ϕ'' in front of the retina of the too long myopic eyeball. In order that a distinct image may be formed in the layer of rods and cones, (*j*), rays of light must diverge before meeting the cornea as shown by the dotted lines.

Astigmatism.—Regular astigmatism signifies a difference in refraction in different meridians of the same eye. It depends upon a want of symmetry of the cornea, the curvature of which is greater in one meridian than in others.

The meridian of greatest curvature is that which has the shortest radius of curvature and the sharpest curve. The meridian of least curvature is that which has the longest radius of curvature and the flatest curve.

The meridians of greatest and least curvature are called *principal meridians* and are always at right angles to each other.

A familiar instance of regular astigmatism is supplied by the back of an ordinary spoon. The misshapen appearance of the reflexion of the face when seen on the back of a bright spoon is well known to all, and is caused by the curvature of its surface being much

sharper from side to side than in the long axis of the spoon bowl.

The phenomena of regular astigmatism are caused by a similar condition of the curvature of the cornea; but in the case of the spoon the image is reflected, whilst in that of the astigmatic cornea the misshapen image on the retina is refracted.

Irregular astigmatism signifies a difference in refraction in different parts of one or several meridians of the eye. It depends upon irregularity in corneal curvature or defects in the crystalline lens. No treatment is of any avail in irregular astigmatism.

Diagnosis of Anomalies of Refraction.

The diagnosis of anomalies of refraction, and of astigmatism, can be made by trial with lenses, by direct and indirect ophthalmoscopic examination, and by keratoscopy.

By trial with lenses.—In order to diagnose and also to measure the "degree" of anomalies of refraction and astigmatism by trial with lenses, we must be provided with the box of trial lenses described at p. 16, and a book of Snellen's types p. 41. Having placed the patient at 6 metres from the card of types from D = 60 to D = 6 or lower numbers D = 5, D = 4, etc., if we have not sufficient space, we try how many of the letters each eye can read. If all or most of the letters can be read we hold before the eye under examination a weak convex lens + ·50 D. If vision is as good with this lens as without, or if sight is improved by it, hypermetropia is certainly present.

If only a few or none of the letters can be made out the eye is probably myopic, and this diagnosis is con-

firmed if the small types S 0·5 or J* 1 can be read near the eye and if distant vision is improved by a concave lens. If the trial gives no satisfactory result vision being below the normal standard both for near and distant letters, and capable of improvement to a limited extent only by convex or concave lenses, some form of astigmatism is probably present, but before testing for it it is well to examine by oblique illumination and with the ophthalmoscope to make sure that the want of sight is not due to opacity of the media, or disease at the fundus of the eye.

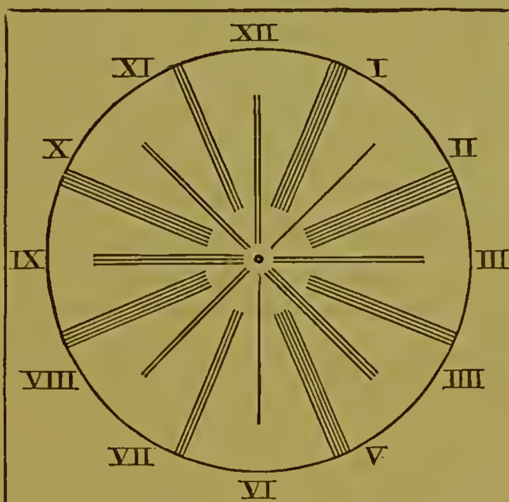

FIG. 27.—Purves' Clock-face diminished to about $\frac{1}{6}$. The disc carrying the lines revolves upon a central axis, so that any bundle of lines can be placed in any position; we judge of the patient's ability to see the lines by his counting the separate strokes in each bundle. If he learns the number in one bundle, and counts without seeing them, we soon catch him by altering the position of the bundles.

The existence of astigmatism is rendered certain by finding that some of the lines on Snellen's fan or on the clock face (Fig. 27) placed at 5 or 6 metres can be seen more distinctly than others without any lens; or that by

* For the sake of brevity we denote Snellen's types as S, Jaeger's as J.

the aid of lenses some of the lines come into view whilst others still remain indistinct, or that those lines which were distinct before are rendered indistinct, the indistinct ones being seen still worse.

Diagnosis by the Ophthalmoscope.

By direct method.—As stated under examination of the erect image, no details of the fundus become plainly visible in emmetropia until the observed eye has been approached to within a distance of two inches or less; if, on the contrary, a blood-vessel, portion of the optic disc, or other object situated at the level of the retina, is *plainly* seen, whilst the observer is still separated from the observed eye by some considerable interval, ametropia certainly exists. The question now arises—What is the form of anomaly of refraction present?

This question is answered by ascertaining whether the object seen is viewed in an erect or inverted position: if the former, hypermetropia exists; if the latter, myopia is present.

The position of the image may be ascertained by either of the following methods:—First, having plainly distinguished some object, a blood-vessel for instance, we steadily approach the observed eye, taking care the while to direct the light properly, and to keep the object in view. If, as the observed eye is approached, we find that the object retains its distinctness, or becomes even more plainly visible, the image is an erect one; the retina is situated within the principal focus of the dioptric system, and the eye is hypermetropic. If, on the contrary, as the observed eye is approached, the object becomes gradually indistinct, and at length fades entirely from view, the image is an inverted one; the

retina lies without the principal focus of the dioptric system, and the eye is myopic.

The second test is: having obtained a *distinct* image of some object occupying the fundus, we move our head from side to side, the observed eye being meanwhile fixed. Should the object seen move in the same direction as our head, the image is an erect one, and the eye is hypermetropic, if in the contrary direction the image is inverted, and the eye is myopic.

If vessels running in one direction are seen either in an erect or inverted image at a distance from the eye, whilst those at right angles to them are seen only when the eye has been approached quite near; or if at a distance some vessels are seen in an erect image, whilst others are seen inverted, regular astigmatism is present. If the vessels or disc appear distorted or broken, or appear to have an irregular wave-like or whirling movement when the observer's head is moved from side to side, there is irregular astigmatism.

By indirect method.—The state of refraction and the presence of astigmatism can be diagnosed by indirect ophthalmoscopic examination, by noticing the behaviour of the image of the optic disc when the distance of the biconvex object lens from the eye is altered. If on withdrawing the lens from the eye the image of the disc becomes smaller, the eye is hypermetropic, if on the contrary it becomes larger, the eye is myopic; if the image becomes oval at the same time that it grows smaller, there is hypermetropic astigmatism; if it becomes oval and larger, there is myopic astigmatism.

In the emmetropic eye no alteration in size of the disc image takes place on withdrawal of the object lens.

By keratoscopy (or retinoscopy) the examination is conducted as follows:—The patient whose pupil is well dilated by a solution of atropine or homatropine being

seated, is directed to look straight forward. The observer should stand or sit at a distance of about a metre and a quarter (a yard and a half) and with the ophthalmoscope reflect the light from the lamp placed above the patient's head upon his eye. As soon as the bright red reflection of the fundus is seen the mirror should be rotated. If ametropia be present a distinct shadow will be seen to pass across the illuminated area. The diagnosis of the anomaly present is decided by the direction of this shadow. If it passes in the same direction as the rotation of the mirror, the eye is myopic; if in the opposite direction, the eye is hypermetropic. In emmetropia and slight degrees of ametropia, the shadow is so faint and moves so rapidly, as to be made out with difficulty; but it moves in a direction opposite to the rotation of the mirror in slight M (below 1 D), H and E. In higher degrees of M and H the shadow is well defined, crescentic in shape, and moves more slowly. If astigmatism be present, a difference will be noticed in the rate of movement and distinctness of the shadow in different meridians; or its passage may be the reverse of the rotation of the mirror in one direction, the same with rotation in the direction at right angles. Thus, with rotation of the mirror on a vertical axis the shadow may pass against, with rotation on a horizontal axis in, the same direction as the movement of the mirror.

Hypermetropia (H).

The hypermetropic eye is, as already stated, too short, from before backwards, the retina lies within the principal focus of the dioptric system (see Fig. 26 *a*) and upon it—provided no change takes place in the

system—a blurred indistinct image of objects—the rays of light from which are parallel—is formed. It is obvious that as the distance of the object from the eye decreases, and the rays of light proceeding from it become more and more divergent, the focus will tend to go still further behind the retina, (see Chap. I., p. 7), and the image upon it becomes still more ill-defined. In order that the hypermetropic eye may see distinctly, even distant objects, the refractive power of its dioptric system must be increased, or rays of light must be rendered convergent before meeting the cornea. The first of these conditions is fulfilled by the accommodation; the second can be provided for by placing a convex lens in front of the eye.

As already shown, the emmetropic eye (Fig. 26 *a*) has no need of accommodation so long as rays of light entering it are parallel, but requires it for diverging rays only.

The hypermetropic eye must, however, accommodate for parallel rays, and must increase its accommodation as the distance of the object becomes less and the rays of light more divergent.

If the power of the ciliary muscle is sufficient, the hypermetropic eye will see both distant and near objects distinctly, and it is obvious that this result will depend upon the amount of shortening of the antero-posterior axis of the eyeball (degree of H), and also on the range of accommodation (see p. 49). From the foregoing it follows that the disturbance of vision caused by hypermetropia is manifested chiefly when the eyes are adjusted for their near point, as in reading, etc., that it is greater in direct proportion to the degree of hypermetropia, and that the symptoms become more urgent in all degrees as age advances, and the range of accommodation decreases.

In old age flattening of the crystalline lens takes place, so that about the age of 65 an emmetropic eye may be unable to focus parallel rays upon its retina; the condition is known as *acquired hypermetropia.*

Symptoms of hypermetropia.—The symptoms of hypermetropia are due to insufficiency of the accommodation (accommodative asthenopia). If the degree of hypermetropia is slight or moderate and the accommodation good no inconvenience is experienced in seeing either distant or near objects. But if the degree of hypermetropia is high, or if accommodation has become weakened by local disease or ill-health, or failed with advancing age, the sufferer will complain that he can no longer see near objects distinctly for any length of time; he will probably state that he can read for a limited period only, that then the print becomes indistinct, the letters appearing to run together, but that if he closes his eyes for a time or rubs them he can continue to read again for a few minutes.

Watering and pain in the eyes are sometimes complained of; severe headache, in some cases frontal, in others occipital or extending down the neck, brought on by using the eyes for any kind of near work is a not uncommon symptom, in moderate degrees of hypermetropia the symptoms do not appear till between the ages of thirty and forty; when the power of accommodation has naturally declined considerably. They may first make their appearance after long periods of study as in working for examinations, in persons suffering from exhausting diseases, or in women after prolonged lactation. Children, as a rule, only manifest symptoms when hypermetropia is of rather high degree; they often blink a good deal, their eyes water and they suffer from headache. In the higher degrees of hypermetropia "muscæ volitantes" are often com-

plained of, and they are usually described as being black like clouds of soot. Their presence is often annoying to the patient, but they need cause no anxiety.

Results of hypermetropia.—The most marked result of hypermetropia is convergent strabismus (see Part II., Chap. III.).

We also frequently find hypermetropic children suffering from repeated attacks of phlyctenular ophthalmia; older persons from red slightly swollen eyelids, chronic conjunctivitis and epiphora, the results of congestion caused by constant strain of accommodation. The refraction should always be carefully tested in all cases of slight chronic or recurring inflammation of any of the ocular structures. Headache has been already mentioned, it is common in hypermetrops of all ages, and the eyes should be carefully examined in all cases of persistent head pain. All forms of astigmatism and the higher degrees of myopia may also lead to like results.

In all the foregoing relief can alone be given by properly selected lenses; lotions, ointments, or constitutional treatment, being all useless without their aid.

Diagnosis, measurement of degree, treatment of hypermetropia.—The diagnosis of hypermetropia has been already given. We can measure its degree in the same manner that we can ascertain its existence—by trial with lenses, by direct ophthalmoscopic examination, and by keratoscopy.

Measurement by trial with lenses.—We conduct the trial with lenses as follows:—Having placed our patient at a distance of 6 m. from the board containing letters from 6 to 60, or at a distance corresponding to lower numbers if we have not 6 m. at our disposal, we cover one eyeand proceed to test the other. If we find that the eye under examination reads 6 at 6 m., and that the same

acuteness of vision is still maintained on the addition of a weak convex lens, we try a stronger and still stronger lens, continuing the trial until we have found the *strongest* lens with which the same letters can still be made out. We can express the degree of hypermetropia by the number of dioptrics of this lens, *e.g.*, if the eye reads 6 at 6 m. and can still make out the letters when a convex lens of 2 D is held in front of it, the degree of hypermetropia may be expressed as H = 2 D.

But the eye under examination may not read letters of 6 at 6 m. either with or without a convex lens, but only those of 9 or 12 or larger. Should this be the case, there may be some impairment of sensibility of the retina, opacity of the media, or the hypermetropia may be complicated by astigmatism. Nevertheless, the degree of hypermetropia may still be expressed by the number of dioptrics of the strongest convex lens with which the greatest acuteness of vision is maintained.

Measurement by direct ophthalmoscopic examination.—If we wish to measure the degree of hypermetropia by means of the ophthalmoscope, we must be provided with one of the many forms of refraction ophthalmoscopes. Oldham's, Purves', Brailey's or Nettleship's will all be found handy instruments. Oldham's ophthalmoscope (Fig. 28) has three separate lens carrying discs, but has this disadvantage that if the lens required is not found in one disc another has to be substituted. In Purves' ophthalmoscope the lens carrying discs revolve one over the other, and by combining different lenses a very large number of powers can be obtained. Having ascertained the existence of hypermetropia, we direct the patient to look at some distant object, and thus relax his accommodation as much as possible; then approach the observed eye till our own cornea is separated from it by an interval of only two inches;

then (taking care to relax our own accommodation) revolve the disc containing convex lenses, placed at the back of the ophthalmoscope until we have ascertained the *strongest* lens through which a *distinct* view of the fundus is still obtained.

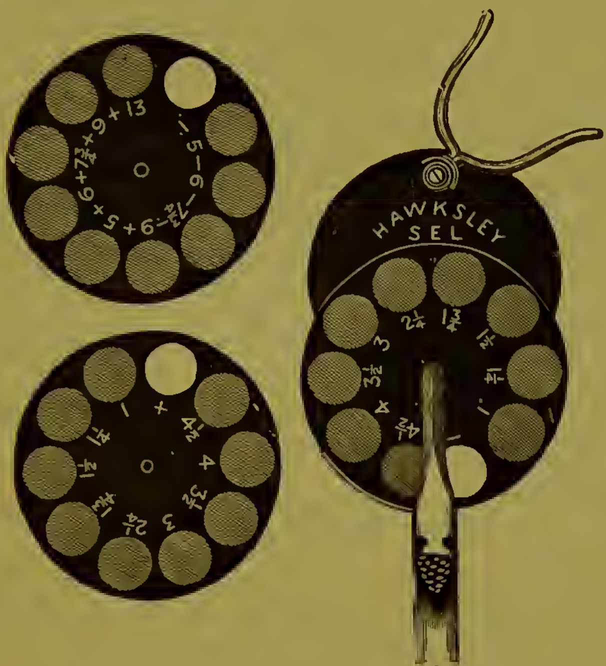

FIG. 28.—Oldham's Ophthalmoscope.

The number of D of this lens expresses the degree of hypermetropia; for instance, if it be found that a clear view of the fundus is obtained when + 1·5 D is placed behind the sight-hole of the ophthalmoscope, and that a *stronger* lens renders the image indistinct, H 1·5 D is present.

If the observer is not emmetropic, he must place that lens which corrects his ametropia in the clip purposely fixed to the instrument in Oldham's instrument before commencing the examination. Or if he be using an

instrument like Purves', not so provided, must wear glasses which correct his ametropia, or having ascertained the strongest + lens with which he sees clearly must subtract his own H or add his own M, *e.g.*, if the observer have H of 1 D and the patient H 2 D, it will be found that the fundus of the observed eye can be clearly seen through a lens of + 3 D, this, however, will be 1 D more than the lens required to correct H in the observed eye. If the observer have M 1 D and the observed eye H 2 D, the fundus will be clearly seen through no stronger lens than +1 D, and 1 D must be added for the observer's M.

Rays of light emerging from the hypermetropic eye are divergent, and the strongest lens with which an emmetropic eye with accommodation relaxed can make out clearly the details of its fundus, is that which gives them a parallel direction, and renders the hypermetropic eye artificially emmetropic.

Measurement by keratoscopy.—The position of patient and observer should be as described at p. 58. A trial frame should be placed on the patient's face. The observer having determined that the movement of the shadow is opposite to that of the rotation of the mirror, should place a convex lens of 1 D in the clip before the eye under examination; if on rotation of the mirror the shadow still passes against its movement a stronger lens must be substituted, and so on, the trial being continued until a lens has been found which makes the shadow commence to move in a direction the same as that of the rotation of the mirror. As stated at p. 58, the movement of the shadow in M of less than 1 D is against the movement of the mirror; consequently the lens which in a case of H reverses the movement of the shadow is too strong and renders the eye slightly myopic, and a lens of about 1 D less strength is that

which corrects the H. Thus if a lens of 3 D reverses the movement of the shadow, the lens required to correct the H will be one of 3 D—1 D = 2 D.

Treatment.—In the treatment of H our object is to render pencils of rays of light convergent before they reach the cornea, so that they may be brought to a focus on the retina by the refractive power without accommodation.

If the patient is in bad health, he must be treated on general medical principles. He should be directed to *wear glasses for all near work*, and these should be the *strongest* with which letters of D 6 can be read at six metres; or if no glasses enable the patient to read D 6 at six metres, the *strongest* with which distant vision is most acute should be ordered. He should also be recommended to rest the eyes for a time, and especially avoid working with insufficient light. If after having used the glasses for a week or a fortnight the patient experiences the same difficulty in doing near work, stronger ones must be ordered.

In ascertaining the degree of H by means of convex glasses, and in a less degree by the other methods, only part of the existing defect becomes apparent, the remainder being masked by accommodation, which the patient is unable entirely to relax. The amount of hypermetropia, which we ascertain by trial with lenses in the manner indicated, we distinguish as *manifest* hypermetropia (H m). The hypermetropia still remaining, but masked by tension of accommodation, is known as *latent* hypermetropia (H l), and becomes *manifest* on artificial paralysis of the accommodative apparatus by means of atropine or other mydriatics.

In most cases of hypermetropia it will be found sufficient to neutralise the manifest portion; but should the symptoms return persistently, in spite of the strength

of the glasses being increased, the accommodation must be thoroughly paralysed by a strong solution of sulphate of atropine (4 grains to 1 ounce), and glasses ordered which correct the whole of the H, both manifest and latent.

In the higher degrees of H (above 3 or 4 D) it may be necessary to give glasses for distance as well as for near work; but the necessity for them depends upon the nature of the patient's occupation, and also his convenience. It must also be borne in mind that as soon as a person takes to convex glasses for distance, he begins to get dependent on them and his vision without them becomes worse, which may in some cases be a serious drawback.

Myopia (M).

In myopia the antero-posterior axis of the eyeball being too long, the retina is placed too far from the dioptric system and only those rays of light which are more or less divergent are brought to a focus on it, parallel or nearly parallel rays being focussed in front of it (Fig. 26 *c*). Consequently, only near objects (the rays of light from which are divergent) are plainly seen; distant objects (the rays coming from which are parallel) are either not seen at all, or only very indistinctly.

In order that the myopic eye may see clearly distant objects, it is necessary to open out the pencil of parallel rays and make them so divergent that after refraction by the dioptric media they are accurately focussed in the retina.

Symptoms of myopia.—The patient complains of being near-sighted. If test-types are given him to read, he will hold them close to his eyes, but if the myopia is uncomplicated he will read the smallest type provided the

book is brought close enough. In some cases of high degree of hypermetropia, especially in young persons and in cases of dull sight, the types may be brought very near the eyes, but the smallest will not be read; the reason is that at no distance is vision distinct; but when the object is held close its image on the retina is larger, and a better idea is gained of it even though its distinctness is less. If told to look at a distance, the myopic person will most probably screw up his eyelids so as to narrow the palpebral aperture, and will only be able to make out objects indistinctly, or not at all. Myopic patients often complain of spots floating before the eyes (muscæ volitantes, p. 50). If suffering from a high degree of myopia (above 4 D) and unprovided with glasses, myops are often round shouldered and stoop; they have a way of peering into things which is quite characteristic.

The age at which the symptoms of myopia first manifest themselves varies with its degree. It is rare to see quite young children short-sighted, but in the higher degrees symptoms may appear at about the age of four or five years; in the more moderate degrees the defect is noticed from about the age of nine to twelve, and in the slight degrees but little complaint is made until puberty or adult life has been reached; indeed some people go through life without ever discovering that they are short-sighted; such are the "wonderful old people" who—as we are told—can read the smallest print to almost any age without the aid of glasses; the too great length of the antero-posterior axis of the globe in their case making up for the failure of accommodation which in emmetropic persons causes presbyopia.

Myopia is progressive and increases up to the age of twenty-five or thereabout; the increase depends upon the amount to which the eyes are used upon near work,

the quality of the work, the conditions under which it is done, and the treatment adopted.

The conditions which favour the development as well as the increase of myopia are use of the eyes on small objects or bad print, with insufficient illumination; too long use on near work of any kind; unsuitable positions, especially those which bring the eyes and the object too near each other (even though the illumination be sufficient), as when a small child is seated on a low stool or form at a high desk; or stooping, caused by the reverse of these conditions. Unfortunately the modern system of education among all classes, but more especially among the lower, is calculated to develop and increase myopia to any extent. The hours are too long, the light, even in daytime, is often bad, and the arrangements for supplying artificial light are often of the worst description.

In some cases of incipient cataract myopia makes its appearance; and is caused either by swelling of the crystalline lens or by increase in its index of refraction. That it is not caused by lengthening of the antero-posterior axis of the eyeball is shown by the fact, that after extraction of the cataract the eye requires the same lenses for *r* and *p* as an emmetropic eye.

Results.—Divergent strabismus is often the result of myopia. Muscular asthenopia frequently occurs in the higher degrees of myopia; the farthest point of distinct vision (*r*) being very near the eyes, great strain of the internal recti is required in order to maintain binocular vision; the result is fatigue, giving rise to the symptoms mentioned in Part II., Chapter III., article "Divergent Strabismus." As in hypermetropia, headache is often complained of, but is not due, as in the former defect, to overstrain of the ciliary muscle—accommodative asthenopia, but to overstrain of the internal recti, it is in fact

but a part of muscular asthenopia. In myopia, as in hypermetropia, we often meet with slight chronic inflammations of the conjunctiva and lids, slight tinea being the most common form; certain morbid changes in the choroid accompany or result from myopia, chiefly of an atrophic nature, and they present very marked ophthalmoscopic appearances.

Posterior staphyloma.—The most commonly observed change is the occurrence of a white or dirty-white more or less crescentic figure bordering the optic disc at its outer margin (Fig. 29). The boundary of the white

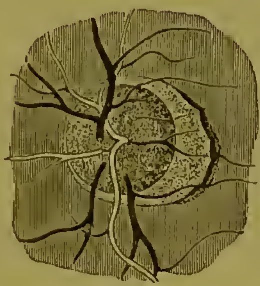

FIG. 29.—Myopic crescent or small posterior staphyloma (Wecker and Jaeger). (After Nettleship).

figure, away from the disc, may have almost any form of outline; in some cases it is clean-cut and well defined; in others it is indistinct, and appears to shade gradually into the adjoining healthy structures. Again, the figure may be seen as an irregular white patch, extending further in some directions than in others; its size varies considerably. In slight cases only a small white rim may be seen bordering the outer margin of the disc; in others, a very considerable atrophic patch will be found; and in some instances the white figure has a somewhat circular form surrounding the whole disc with a white band, the breadth of which is usually greatest next to

the outer side (Fig. 30). This change, known as *posterior staphyloma*, is brought about by a yielding of the ocular tunics to intra-ocular pressure. The yielding is probably always preceded by inflammatory softening; as it progresses the choroid becomes separated from the margin of the disc and disintegration and atrophy follow. The white appearance of the figure is due to the light from the ophthalmoscope being reflected from the sclerotic, which is left uncovered by destruction of the choroid.

FIG. 30.—Large annular posterior staphyloma (Liebreich). (After Nettleship).

A staphyloma of greater or less extent exists in nearly all myopic eyes, but occasionally it is so ill-defined or so small as to be overlooked. The depth and extent of the staphyloma bear a distinct ratio to the degree of myopia; in low degrees it is small, in high degrees large, and in all it is prone to progress and with it the degree of myopia to increase. The edge of the staphyloma away from the disc should always be carefully examined; if it is well-defined and clean cut the myopia is probably stationary, but if ill-defined and ragged and the choroid next it reddened or blood-

stained the myopia is on the increase and every precaution must be taken.

In some cases of posterior staphyloma the disc seems altered in form, appearing oval, and, as it were, fined off towards the white figure. This change in the disc is not real, but apparent, and is caused by its being situated on the sloping side of the staphyloma, so that its inner border lies nearer the observer than its outer, its transverse diameter consequently appearing shortened. The retina is moreover dragged in a fold over the inner surface of the disc by the stretching which it undergoes on the outer side over the staphyloma. As a consequence the retinal vessels undergo a change in direction, and are seen to curve in passing over the white figure; they may also seem wholly displaced towards it, and do not—as in the normal condition—divide the disc into two lateral halves, but turn entirely to that side of it which is next the staphyloma. The disc is sometimes found whiter than usual and the retinal blood supply may be below par.

It must not be forgotten that there is a source of fallacy in estimating the size of objects situated in the fundus of the myopic eye. When examined with the ophthalmoscope by the indirect method, the objects seen always appear much smaller than in emmetropic or hypermetropic eyes. This depends on refraction and might lead to an erroneous diagnosis with regard to the retinal blood supply.

Besides the changes which take place about the optic disc the choroid is frequently much thinned throughout, the pigment being destroyed and the large vessels forming its outer layer exposed to view. Atrophic patches, having more or less circular and well-defined or irregular ill-defined borders, together with dark patches and dots consisting of heaps of pig-

ment, are frequently seen scattered about the fundus without any particular arrangement. Atrophic changes are sometimes seen in the region of the yellow spot, in the form of irregular white patches, or of radiating lines looking as if the choroid was stretched and cracking, and we sometimes see a nearly circular dark spot of pigment occupying the position of the spot itself. These changes about the yellow spot are most serious as central vision is much impaired or destroyed by them.

The term malignant myopia is applied to cases in which the choroidal changes are exclusive.

Other morbid changes resulting from or accompanying myopia are morbid fluidity of the vitreous, diagnosed by a tremulous condition of the iris, and free movement of vitreous opacities which are frequently present. Detachment of the retina, choroidal hæmorrhage, secondary cataract, and glaucoma also occur.

Diagnosis, measurement of degree and treatment.—We have already seen (pp. 54—58), how to diagnose the existence of myopia; its degree, like that of hypermetropia, can be measured by trial with lenses, by ophthalmoscopic examination, and by keratoscopy. Its treatment is not quite so simple as that of the preceding anomaly.

Measurement of degree of myopia by trial with lenses should be conducted thus:—We place the patient complaining of near sight at a distance of 6 m. from the card, on which are pasted the letters from 6 to 60, and ask him to try to read them with each eye separately. If he is suffering from at all a high degree of myopia, he will not be able to distinguish any of the letters; if, however, any of them can be made out, concave glasses beginning with a weak one about 1 D may be immediately tried; but if none can be read, we place the book of small types in the patient's hand, and note carefully the distance at which he reads type 0·5 or

0·6 Snellen, or 1 or 2 Jaeger. We shall generally find that the concave lens, the negative focal length of which corresponds to the greatest distance at which the eye reads distinctly, or a lens a little stronger or weaker than this, will neutralise the myopia. For instance, if in reading the patient holds the types at 20 centimètres it will be found that a concave lens of 20 centimètres negative focus, *i.e.*, a lens of 5 D will be about the one which will improve distant vision most. Having ascertained the distance at which small type can be read, we direct the patient to look again towards the board (on which are letters from 6 to 60) and hold concave lenses, beginning with that the focal length of which corresponds to the distance at which small type is read, in front of the eye under examination, until we have ascertained the *weakest* with which letters of 6 can be read at 6 m.; the degree of myopia may then be expressed by the number of dioptrics of this concave lens. For instance, if it is found that a concave lens of 4 D is the weakest with which letters of 6 can be read at 6 m., the degree of myopia is expressed as 4 D; if, however, letters of 6 cannot be read at 6 m., but only 12, 18, 36, or even 60, the degree of myopia may still be expressed by the number of dioptrics of the *weakest* concave lens with which *the greatest possible acuteness of vision* is maintained.

In many cases of myopia, especially those of high degree (above 6 D), we find that the acuteness of vision has very much diminished; the failure of sight is due in most cases to some of the morbid changes already described.

Measurement of degree of myopia by the ophthalmoscope.—In order to ascertain the degree of myopia by the ophthalmoscope, a refraction instrument (as in hypermetropia) must be used; but as the retina is situated behind the focus of the *dioptric system*, an

image of it is necessarily formed at some point (conjugate focus) in front of this system and outside the eye.

Consequently, the rays of light emerging from the myopic eye are not parallel as in emmetropia, or divergent as in hypermetropia, but are converging to a point situated further from or nearer to the eye, according to the degree of myopia.

Now, the emmetropic eye cannot accommodate itself for convergent rays of light; consequently, if the observed eye is looked at from a distance less than that of the point to which the emergent rays converge, no image will be formed upon the observer's retina. But if the eye is examined from a point situated at a distance somewhat greater than that to which the emergent rays are directed, an inverted aërial image is plainly seen, which is lost as the observer approaches near the point at which the image is formed.

An approximate estimate of the degree of myopia may be made by noticing the distance from the observed eye at which this disappearance of the inverted image takes place, as the observer, if emmetropic and not yet presbyopic, can approach to within about 15 cm. of it, and still see it clearly; for instance, if it is found that the inverted image disappears at a distance of 30 cm., we may conjecture that it is in reality situated at about 15 cm. from the observed eye, and that a myopia of $\frac{100}{15}$ about 6·5 D exists.*

The more accurate plan of measurement—having ascertained the existence of an inverted aërial image, and therefore of myopia—is to take no notice of its distance from the eye, but commence the examination at

* 15 cm. is the focal length of a lens of 6·5 D. We arrive at the number of D of any lens of which we know the focal length in cm. by dividing 100 by the number whatever it may happen to be. If we wish to know the focal length of any number of D, we divide 100 by that number.

once, a distance of only two inches separating our own cornea from that of the observed eye, revolve the disc containing the concave lenses fixed behind the sight-hole of the ophthalmoscope, until we have found the *weakest lens*, which so opens out the convergent pencil of rays as to allow of a distinct erect image of the parts occupying the fundus of the examined eye being seen. The number of dioptrics of this lens will represent the degree of myopia. The observer's eye if not emmetropic must be rendered so, or an addition made if hypermetropic, a deduction if myopic. Thus, if hypermetropic he will under-estimate the myopia by the amount of his own hypermetropia, if myopic, he will over-estimate the myopia by the amount of myopia in his own eye.

Measurement by keratoscopy.—We proceed exactly as in the measurement of hypermetropia, but having ascertained that the movement of the shadow is with the rotation of the mirror, we place concave lenses in the trial frame until the weakest has been found, which makes the shadow commence to move against the mirror. As stated at p. 58, the movement of the shadow is against the mirror in hypermetropia, emmetropia and slight myopia. Consequently the concave lens which just makes the shadow move against the mirror, does not quite correct the myopia, but leaves about 1 D, so that by keratoscopy we under-estimate the degree of myopia by that amount, and must add 1 D if we wish to express the whole myopia present. Thus, if a lens of —3 D is the weakest which makes the shadow move against the mirror, the myopia present is not 3 D, but 3 D + 1 D = 4 D.

Treatment.—In the treatment of myopia our object is to so open out pencils of parallel rays of light that they fall divergent upon the cornea, and so appear to come from a near object. Slight degrees of myopia do not

give rise to much inconvenience, the patient being able to read or work at a fair distance; it is only when looking at a distant object that the defect of vision is noticed, and no treatment is *necessary*.

If much inconvenience is experienced from the limitation of distant vision, a pair of glasses may be ordered, and these should be *the weakest concave lenses* with which the greatest acuteness of vision can be maintained; they need only be used when looking at a distance. Higher degrees of myopia, where the farthest point of distinct vision is situated only at a few inches from the eye, always require attention from the great tendency of the myopia to increase, and with it the choroidal changes mentioned above. The treatment consists in the selection of suitable spectacles, and the avoidance of all conditions likely to cause congestion of the eyeballs.

In the selection of glasses we must be guided by the circumstances of the case and the age of the patient. In children with good accommodation, and myopia not exceeding 5 D, the degree of myopia should be carefully ascertained, and glasses which accurately neutralise it ordered to be used for all purposes. Occasionally it will be found that the glasses make the eyes ache when used for a considerable time for near work; but this is only caused by the unaccustomed exercise of accommodation, and will usually pass off if the use of the glasses is persevered in, and near work only done for a short time at once, until the eyes become used to the extra strain. Should the symptoms, however, continue, or increase after a fair trial, the glasses must be replaced by weaker ones, which should be worn for some weeks, after which those which fully correct the myopia may be again tried.

In myopia above 5 D, or in persons with less degrees who have reached puberty without wearing glasses, an

absolute correction cannot be borne, and can only do harm if tried. In these cases, having first carefully ascertained the degree of myopia, we must order glasses which neutralise about two-thirds of it. These should be used for all purposes for some weeks, at the end of which time stronger ones may be given; the strength being gradually increased until the whole, or nearly the whole, of the myopia has been corrected.

In many cases it will be found useful to order a pair of spectacles which enable the patient to do near work at a fair distance (50 cm.); and to give spectacles or a double eye-glass, with lenses which accurately neutralise the myopia, to be used for looking at distant objects only.

In some cases of myopia the degree will be found to be greater in one eye than in the other. If there is no considerable difference, a different glass may be ordered for each; but if the defect in one eye is considerably in excess of that in the other, no good will result from different glasses, and we should give for both eyes those lenses which suit the less myopic one, their selection being governed by the rules already laid down.

Congestion of the eyeballs often occurs in myopia and is brought about by the conditions already mentioned. To obviate it certain precautions should be taken. Myops can see with less illumination than hypermetrops, or even emmetrops, and are often very fond of reading or working in twilight, or by the light of a fire, but they should never be allowed to read or work by a bad light. Attention must also be paid to position, they should not be allowed to read lying down, or to stoop over their books or work. Stooping can be avoided by using a desk or rest, which raises the book to a suitable height, or by holding the book up to the eyes in myopia of 3 to 5 D; in myopia above 5 D by the use of glasses.

A considerable factor in causing increase of myopia is

the compression of the eyeballs caused by the internal recti muscles when convergence is excessive, as in the higher degrees of myopia (8 to 10 or 12 D); this can be avoided by the use of glasses which correct sufficient of the myopia to allow the patient to see clearly at 22 cm. (8 inches) or rather further from the eyes.

In the very high degrees of myopia (16 to 20 D) occasionally met with, the patient had better not use glasses, but content himself with seeing what he can without; he should read but little, and if employed on any work should do it by feeling as if entirely blind. Highly myopic eyes are very unsound, and if used much upon near objects, are very liable to become quite blind, from detachment of the retina, choroidal hæmorrhage, or other cause.

Not unfrequently in the course of myopia there arise what are known as *symptoms of irritation;* these consist in the occurrence of flashes of light, fiery sparks and circles, photophobia, a sense of fulness, and sometimes pains in the eyeballs.

Whenever symptoms of irritation occur, they must be looked upon as of considerable import, and requiring careful management; their occurrence usually means increase of the myopia.

If glasses are being worn, their use must be discontinued; all work should be abstained from; the patient, when indoors, should be kept in a subdued light; and when in the open air, blue or smoked protectors should be worn. In extreme cases an entirely dark room must be prescribed, all excitement must be avoided, and alcoholic and hot drinks abstained from. Cold douches should be used to the eyes and forehead; and in many cases great benefit will be derived from the abstraction of blood from the temples, either by the application of natural leeches or of the artificial leech—the latter,

however, being preferable. The treatment must be persevered in until the symptoms have entirely subsided, and great care must be subsequently taken to avoid a recurrence.

The existence of "muscæ volitantes," unless there be opacity of the media visible by the ophthalmoscope, need give rise to no uneasiness.

We must bear in mind when prescribing glasses for myopia, to be careful never to order them too strong.

Presbyopia (*old sight*) though not an anomaly of refraction, may appropriately be considered here, as its treatment is optical, and it is influenced by the condition of refraction.

Presbyopia depends on senile change of the crystalline lens, by which it is rendered harder than in youth and its elasticity impaired. As a consequence its curvature can only be altered to a limited extent by the action of the ciliary muscle, and the amplitude or range of accommodation is correspondingly diminished.

Persons generally begin to experience the effects of presbyopia from the age of forty-five to fifty. The nearest point of distinct vision, which year by year has been receding from the eyes, now becomes inconveniently far off, so that small print can only be read with difficulty, or not at all; distant vision, however, still remains acute.

It has been arbitrarily decided that a person shall be considered presbyopic as soon as his nearest point of distinct vision comes to stand at twenty-two centimètres or further from the eyes, and the degree of presbyopia is expressed by the number of D which it is necessary to give the eye in order to bring its near point up to this distance; or, in other words, to give it a refractive power equal to 4·5 D, which is the power of the lens which the crystalline must add to itself in order

to see distinctly at twenty-two centimètres. Thus, a person aged forty-five can only see distinctly at twenty-eight centimètres, that is, he can only add to his crystalline a lens equal to 3·5 D. In order to enable him to see distinctly at twenty-two centimètres we must give a lens which makes up the difference between 3·5 D and 4·5 D, *i.e.*, 1 D. A person of forty-five, therefore, requires a convex lens of 1 D to remedy his presbyopia; the number of this lens also expresses the degree of presbyopia.

It has been determined by observation that presbyopia increases by one dioptric for every period of 5 years from 40 to 60; sometimes by one dioptric and sometimes by a half only, for each similar period from 60 to 80.

The following table shows the lens required at each period of five years by the emmetropic eye. Should hypermetropia exist its degree must be ascertained and added to the number given in the table. The degree of myopia, on the contrary, must be subtracted:

Age.	Dioptrics.	Age.	Dioptrics.
40	0	65	4·5
45	1	70	5·5
50	2	75	6
55	3	80	7
60	4		

Should our patient require to see at some particular distance, the numbers in the table need not be adhered to; he may be allowed to select those lenses which he thinks suit best. As a matter of fact we often find that the glasses given in the table are too strong, especially in hypermetropic persons who have become presbyopic before taking to glasses. Such persons have long been accustomed to strain their accommodation to the utmost,

and will not thank us for giving them glasses which neutralise the whole of their hypermetropia as well as their presbyopia. We shall give much greater satisfaction by ordering glasses which a little more than neutralise the hypermetropia, and so give a little help without being an absolute correction.

Astigmatism (As).

A certain amount of regular astigmatism is present in the cornea of the emmetropic eye. Its maximum of curvature (that which has the shortest radius, and consequently the shortest focal length) is found in the vertical meridian; its minimum of curvature (that which has the longest radius, and consequently the longest focal length) is found in the horizontal meridian. If the degree of asymmetry is so slight as to give rise to no impairment of vision, it is known as *normal astigmatism*, or *astigmatism of the normal eye.* But if, on the contrary, defective vision is produced by the asymmetry, it is known as *abnormal astigmatism.*

The existence of normal astigmatism can be very easily demonstrated. If we draw two fine lines on paper, crossing each other at right angles, and look at them in such a position that they shall correspond to the vertical and horizontal corneal meridians, a distance will be found for every emmetropic eye at which the vertical line can be seen more distinctly than the horizontal, and *vice versâ.*

The question at once arises, why should this difference exist? To answer it, we must understand what are the conditions necessary in order to see a vertical or horizontal line distinctly.

To see a vertical line distinctly, it is requisite that rays of light proceeding from it in a *horizontal direction*, and

therefore passing through the horizontal meridian of the cornea, should be brought to a focus in the retina.

To see a horizontal line distinctly, it is necessary that rays of light proceeding from it in a *vertical direction* and therefore passing through the vertical meridian of the cornea, be brought to a focus in the retina. As a consequence of this, vertical lines may be considered as belonging to the *horizontal* corneal meridian, and horizontal lines to the *vertical* meridian.

As has been already stated, the curvature of the cornea, has the shortest radius and shortest focal length in its vertical meridian, the longest in its horizontal; consequently it will be found that a fine horizontal line can be *distinctly* seen at a shorter distance than a fine vertical line, a fine vertical line at a somewhat greater distance than a horizontal.

By practising the simple experiment just mentioned, any individual whose eyes are emmetropic can prove to himself the existence of normal astigmatism. What has been said with regard to vertical and horizontal lines applies with equal force to those drawn in any direction. In order to see any line distinctly, rays of light passing through that meridian of the cornea which is at right angles to it must be brought to a focus in the retina. This rule should be borne in mind when working out astigmatism with test lines.

Abnormal astigmatism.—In abnormal astigmatism we find that most frequently the greatest curvature (that which has the shortest radius) of the cornea is in, or approaching to, the vertical meridian; and the least curvature in, or approaching to, the horizontal meridian. The two principal meridians—those of the greatest and least curvature—always stand at right angles to each other.

There are five forms of abnormal astigmatism—in

two, one principal meridian of the cornea is normal, that at right angles to it deviating in the direction of too great or too slight a curvature; the first constituting *simple myopic astigmatism*, the second *simple hypermetropic astigmatism*. In the third form the whole eye has a myopic refraction, but the curvature of the cornea, in one principal meridian is in excess, and consequently the myopia in that meridian increased. This condition is known as *compound myopic astigmatism*. In the fourth the whole eye has a hypermetropic refraction, but the curvature of the cornea in one principal meridian is diminished, and consequently the hypermetropia in that meridian increased. This condition is known as *compound hypermetropic astigmatism*. In the fifth form the curvature of one principal meridian is too great, causing myopia in that meridian; the curvature of the meridian at right angles to it being too slight, and giving rise to hypermetropia. This condition is known as *mixed astigmatism*.

Symptoms.—The symptoms of astigmatism are similar to those of ametropia, but do not point so plainly to the variety present. Thus the patient will complain, in all forms, of difficulty in reading or doing near work; and whether, the defect be myopic, hypermetropic, simple, compound, or mixed will hold the book or work too near the eyes; he will moreover very likely tell us that he does not see at any distance well, but that near work troubles him most. Pain in the eyes and *headache* brought on or aggravated by looking intently at any object, but more especially at near ones are frequent complaints.

The age at which astigmatism gives evidence of its existence depends upon its degree. If of high degree, 4 to 5 or 6 D, difficulties arise as soon as the child's education is commenced; lower degrees, 1, 2 or 3 D,

manifest themselves during school-life, whilst the low degrees ·25, ·50, ·75 D may give no trouble at all, or are only discovered after presbyopia has commenced at from 45 to 50 years of age. On the other hand, quite low degrees may give much trouble to young adults who are rather hyperæsthetic and make much use of their eyes either in close study or some kind of fine work.

Astigmatics of all ages will generally complain that glasses, which they have probably selected for themselves, do not help them; or that they give some assistance at first, but do not enable them to read or work for any length of time. This is markedly the case in those who have become presbyopic; they will probably have procured weak convex lenses, known as "clearers," and having found them of not much assistance will have changed them for stronger ones with a like result. When a patient above forty-five presents himself saying that he cannot get glasses to suit him for reading we may predict with certainty that he suffers from a low degree of astigmatism.

We must also remember that in low degrees of hypermetropic astigmatism, distant vision may be normal; so that the fact that a person's $V = \frac{6}{6}$ and that no manifest hypermetropia (H m) can be found, does not preclude the existence of slight hypermetropic astigmatism, which must be carefully sought for in all cases of discomfort in reading or working which is not removed by the use of convex spherical lenses.

The diagnosis of astigmatism has been already given; like hypermetropia and myopia its degree can be measured by trial with lenses, by direct ophthalmoscopic examination, and by keratoscopy. Much trouble will be saved if, before attempting to measure the degree of astigmatism by any method, a solution of sulphate of

atropine,* gr. iv. to ℥ i, be dropped into the eyes three times a day for two or three days, so as to thoroughly paralyse the accommodation. When accommodation is at rest, especially in cases of hypermetropic astigmatism, the difficulty in ascertaining the degree of astigmatism is much lessened, and a more correct result is obtained than when accommodation is active.

The result obtained, however, when the eye is tested under the influence of a mydriatic, though more correct and more scientifically arrived at is not always so satisfactory to the patient; and as a matter of practical experience it will be found that patients much prefer to use glasses which correct the astigmatism found when accommodation is active than those which neutralise that found when accommodation is paralysed. Consequently, in spite of the extra trouble and without regard to the scientific aspect of the proceeding, it is best to work out the majority of cases without the aid of mydriatics, leaving their use for those cases only in which no satisfactory result can be obtained without their employment.

Measurement by Trial with Lenses.

Place the patient, whose refraction should have been roughly tested and the condition of the media and all parts of the fundus ascertained by ophthalmoscopic examination, at five or six meters from the clock face, figured at p. 55, or Snellen's fan, cover one eye and ascertain whether or no the other can make out any of the lines without the aid of a lens; if any line can be distinctly seen, its direction should be carefully noted. This at once gives a clue to the form of astigmatism present; and the

* A solution of hydrobromate of homatropine does nearly as well as that of sulphate of atropine, and its effects pass off sooner, and the patient is saved the inconvenience caused by a week or fortnight's inability to accommodate for his near point.

previous trial of refraction will, in all probability, have furnished evidence of myopia, or hypermetropia, although no satisfactory result has been obtained.

Simple myopic astigmatism.—Let us suppose that a line running in a vertical or nearly vertical direction is plainly seen; from what has been said respecting the conditions necessary for seeing a vertical line distinctly, we know that the meridian of the cornea situated at right angles to the line which is plainly seen has either a normal or too slight (hypermetropic) curvature. We then direct the patient to keep his eye fixed on this line, and hold a weak convex and concave lens alternately before it; if the line is rendered less distinct by the former, and not much altered by the latter, we at once diagnose emmetropia in a meridian approaching the horizontal. Our next care is to ascertain what lens will enable the eye to distinguish a line running at *right angles* to that which is seen without such aid.

The trial should be commenced with that lens, convex or concave, which in the previous trial of refraction was found to give the greatest acuteness of vision: this lens, in the case supposed, will in all probability be a concave one. Such being the case, we continue the trial until the *weakest* concave lens has been found which renders distinct the line standing at right angles to that first seen. In the case supposed, simple myopic astigmatism is present and its degree may be expressed by the number of D of the weakest concave lens which renders distinct the line running at right angles to that which is most clearly seen without a lens; supposing the lens to be one of 2 D, the degree of astigmatism = 2 D. (As m = 2 D, *i.e.*, myopic astigmatism of 2 D).

In order to check the result obtained, a cylindrical lens of 2 D should be held before the eye, its axis being placed parallel to the line seen clearly with 2 D. If a

proper correction has been obtained, the test-lines will all appear the same, and the acuteness of vision will be found considerably increased.

The other forms of astigmatism are also to be diagnosed by means of the test-lines and trial with lenses.

Simple hypermetropic astigmatism.—In simple hypermetropic astigmatism when accommodation has been paralysed by atropine or other mydriatic, it will generally be found that the horizontal or nearly horizontal lines are most distinctly seen, and that they are rendered less distinct by the addition of convex lenses, whilst those running at right angles to them are distinguished as easily or more easily than before. The trial with lenses should be continued until the *strongest convex lens* has been ascertained, with which the latter can still be distinguished. The degree of astigmatism may be expressed by the number of dioptrics of this lens. Suppose the correcting lens to be + 2 D, then the astigmatism = 2 D. (As h = 2 D, *i.e.*, hypermetropic astigmatism of 2 D).

The result obtained must be checked by trial with a convex cylindrical lens, the axis of which must be placed parallel to the line seen with +2 D, *i.e.*, in a more or less vertical direction.

Compound myopic astigmatism.—In cases of compound myopic astigmatism, distant vision is generally so imperfect that none of the test-lines can be made out at six meters. Trial with concave lenses commencing with that which has been previously found, during the trial of refraction, to raise the acuteness of vision most, quickly enables the eye to recognise some of the lines. As soon as any line can be recognised, careful trial should be made until the weakest concave lens with which it can still be clearly seen has been ascertained. Having done this, we should next find the weakest concave lens

with which a line running in a direction at right angles to that at first seen is clearly made out. The strength of this lens will usually be found to be greater than that of the first. The difference between the two expresses the degree of astigmatism.

Supposing it is found that no lines are made out at first, but that with a lens of —2 D, those having a vertical or nearly vertical direction are brought clearly into view, and that a lens of —4 D is required to enable the eye under examination to see lines running at right angles to those first distinguished; we learn from this result; (1) That in the horizontal or nearly horizontal meridian of the cornea there is myopia of 2 D; (2) That in a meridian at right angles to this there is myopia of 4 D. To neutralise this we employ a spherical *concave* lens of —2 D, which of course corrects 2 D of myopia in all meridians; but we have found by our trial that in one meridian myopia of 4 D exists; consequently, the spherical lens only neutralises $\frac{1}{2}$ of the defect in this meridian, another 2 D still remaining. In order to correct the remaining myopia, a cylindrical lens of 2 D must be combined with the spherical, the axis of the cylinder being placed parallel to the line seen with the stronger of the two lenses, *i.e.*, in a more or less horizontal direction.

In the case supposed, there is myopia 2 D (M = 2 D), and, besides this, myopic astigmatism 2 D (As m = 2 D), 2 D being the difference between the two meridians.

The result obtained must be checked by testing the acuteness of vision both for lines and letters with a concave spherical lens of 2 D, combined with a concave cylindrical one also of 2 D.

Compound hypermetropic astigmatism can be diagnosed by the use of lines and trial with lenses in the

same manner as the compound myopic, but with this difference, however, that the lenses employed are convex instead of concave. It will generally be found that the eye affected by compound hypermetropic astigmatism, when its accommodation is paralysed, has the greatest acuteness of vision for lines running in a more or less horizontal direction, those running in a direction at right angles to these being less distinctly seen.

Having ascertained which of the lines is most distinctly seen, we commence the trial with convex lenses, using first that which was found to give the greatest acuteness of vision during the trial of refraction. Stronger and stronger lenses should then be tried, until the strongest with which the particular line or lines can still be made out has been ascertained.

Our next care must be to find the strongest convex lens with which lines running at right angles to those at first seen can still be made out.

The strongest lenses which give the greatest acuteness of vision for lines more or less horizontal, and for those more or less vertical, having been ascertained, the degree of astigmatism is expressed by the difference between them. Thus, if lines running in a horizontal direction can still be made out with a convex lens of 2 D, the presence of 2 D of hypermetropia in the vertical meridian of the cornea is demonstrated. If lines running in a vertical direction can be made out through a convex lens of 4 D, there is hypermetropia of 4 D in the horizontal meridian, and the degree of astigmatism is 2 D. There is hypermetropia of 2 D in all meridians, with an additional 2 D in the horizontal (H = 2 D, As h = 2 D), *i.e.*, hypermetropia 2 D, with hypermetropic astigmatism 2 D. The required correction will be a convex spherical lens of 2 D, combined with a convex cylindrical lens also of 2 D, the

axis of the cylinder being placed in a more or less vertical direction.

The correction must be checked by trial of the acuteness of vision for lines and letters when looked at through the above combination of lenses. The measurement of hypermetropic astigmatism, whether simple or compound, when accommodation is active, is not quite so simple; the patient will constantly alter his accommodation and see first one line and then another, at times with a glass at others without, or the same line may be seen at one moment with a glass at the next it cannot be seen; as the patient often describes it, the "lines come and go."

Mixed astigmatism can also be diagnosed by ascertaining the acuteness of vision for lines running in different directions, both by trial with lenses and without such aid.

In this form of asymmetry, the eye under examination will probably be found to have a greater power of distinguishing lines which run in a more or less vertical direction than those which have a horizontal inclination, when the half-circle or clock-face is placed at a distance of five or six meters.

Let us suppose that on testing an eye, the trial of refraction of which has given no satisfactory result, it is found that lines having a vertical direction are seen with tolerable distinctness. We at once suspect that the meridian at right angles to the lines thus distinguished has a normal or too slight (hypermetropic) curvature. We commence the trial with weak convex lenses; if it is found that vision for the same lines is as acute with these as without, or that the sharpness of sight increases, hypermetropia in the horizontal meridian of the cornea is certainly present. The existence of hypermetropia in the horizontal meridian having been

proved, our next care is to ascertain its degree; this is done by finding the *strongest* convex lens with which vertical lines can still be distinctly seen, the number of D of this lens then expresses the degree of hypermetropia. Suppose the lens to be one of 2 D the degree of hypermetropia in the horizontal meridian is 2 D (As h = 2 D, *i.e.*, hypermetropic astigmatism 2 D).

We next proceed to ascertain the refraction in the vertical meridian; it will be found that the convex lenses which did not affect the vision for vertical lines, render horizontal ones still less distinct than before. We then try concave lenses; and if it is found that the vision for horizontal lines is improved, we continue the trial until the *weakest* concave lens with which the greatest attainable acuteness of vision for horizontal lines is maintained, has been ascertained. The number of D of this lens then expresses the degree of myopia in the vertical meridian. Supposing the lens to be one of 2 D, then the degree of myopia is 2 D; and the eye under examination has, besides hypermetropic astigmatism, As m = 2 D, *i.e.*, myopic astigmatism 2 D. The combination required to neutralise this defect will consist of a convex and a concave cylindrical lens, each of 2 D, placed with their axes at right angles to each other, that of the convex lens being vertical, that of the concave horizontal. In this case, however, the degree of astigmatism is not the difference between the two lenses which would be *nil*, but their sum, *i.e.*, 4 D.

Measurement by direct Ophthalmoscopic Examination.

Ascertain what the refraction of the eye is; having made out the presence of hypermetropia, myopia, or a mixture of the two, approach the eye as near as pos-

sible. If the case is one of hypermetropic astigmatism the disc and all the retinal vessels will be plainly seen; there will very probably, however, appear to be an unusual clearness of the lateral boundaries of the disc and of the vertical vessels. Next look for a vessel of moderate size having any direction; keep it carefully in view and revolve the disc containing convex lenses behind the sight-hole of the ophthalmoscope until the *strongest* with which the particular vessel can still be seen distinctly has been ascertained. The number of this lens will give the degree of hypermetropia in a meridian at *right angles to the direction of the vessel.* Next take a vessel of about the same size as the first, but running in a direction as nearly as possible at right angles to it, and ascertain the strongest lens with which it can still be seen. If it is found that, though all the vessels can be plainly seen when no convex lens is placed behind the sight-hole of the ophthalmoscope, but that the interposition of quite a weak one blurrs some of them, whilst others remain distinct, the conclusion to be drawn is that the case is one of simple hypermetropic astigmatism. In such a case if a lens of + 1 D blurs horizontal vessels, whilst those having a vertical direction are still distinctly seen, but become indistinct on placing + 1·50, behind the sight-hole, the eye is emmetropic in its vertical meridian, but there is hypermetropia 1 D in the horizontal meridian, *i.e.*, simple hypermetropic astigmatism of 1 D. If all the vessels are still distinctly seen through a lens of + 1 D, but on the addition of + 1·50 some of them (the horizontal for instance) become blurred, the vertical being still plainly seen through + 2 D, but becoming blurred on the addition of a stronger lens, compound hypermetropic astigmatism is present, and its degree is expressed by the difference betweên the strongest lenses through which horizontal and vertical

vessels can still be seen. In the case supposed, 2 D being the strongest lens through which vertical vessels are plainly seen, hypermetropia 2 D exists in the meridian at right angles to these vessels, *i.e.*, the horizontal meridian; 1 D being the strongest lens through which horizontal vessels can be plainly seen, hypermetropia 1 D is present in the meridian at right angles to these vessels, *i.e.*, in the vertical meridian, and the whole eye has hypermetropia 1 D with hypermetropic astigmatism of 1 D, 1 D being the difference between the strongest lenses through which vertical and horizontal vessels respectively can be clearly seen.

What has been said of vertical and horizontal vessels applies equally to vessels running in any other direction; the strongest convex lens through which a vessel running in any direction over the fundus can be clearly seen shows the degree of hypermetropia in the meridian at right angles to that vessel.

In simple myopic astigmatism, it will be found that when the eye is approached quite near, some of the vessels are clearly seen in an erect image, whilst those at right angles to them are much blurred or scarcely visible. The addition of a convex lens will blur the vessels which before appeared distinct; the addition of a concave lens will render the vessels at first seen rather more distinct, whilst the blurred ones will become clearer; and the addition of stronger concave lenses will at length render the blurred vessels distinct. The strength of the *weakest* concave lens through which a vessel running in any direction over the fundus is clearly seen expresses the degree of myopia in the meridian at right angles to that vessel. Suppose the vessels clearly seen with no lens behind the sight-hole of the ophthalmoscope and blurred by a weak convex lens, have a vertical direction, and that those seen indistinctly and ren-

dered clear by a concave lens of 2 D and by no weaker lens, have a horizontal direction, emmetropia is present in the horizontal meridian, with myopia of 2 D in the vertical meridian; the case is one of simple myopic astigmatism of 2 D in the vertical meridian. In compound myopic astigmatism all the objects occupying the fundus of the eye when looked at quite close appear blurred, or are quite invisible. If the disc containing concave lenses is revolved, a lens will presently be found with which some vessel is clearly seen; the strength of the weakest lens with which this result is obtained, shows the degree of myopia in the meridian at right angles to this vessel. If the disc is turned still further, a lens will be found with which a vessel at right angles to that at first seen becomes distinct, the strength of the weakest lens which produces this effect, gives the degree of myopia in the meridian at right angles to this vessel. It will be noticed, however, that all the vessels appear well-defined through this lens.

Suppose a vertical vessel to be plainly seen through a concave lens of 2 D and through no weaker one, whilst the weakest concave lens which renders a horizontal vessel distinct is 4 D, myopia 2 D is present in the horizontal meridian and myopia 4 D in the vertical; the case is one of myopia 2 D with myopic astigmatism 2 D the greatest myopia being in the vertical meridian. What has been said with regard to vessels running in other directions than horizontal and vertical, when speaking of hypermetropic astigmatism, applies equally to myopic astigmatism, with these exceptions; that the lenses are concave instead of convex, and that the *weakest* and not the *strongest* lens expresses the degree of myopia at right angles to the particular vessel which is clearly seen through it. The reason why stress is laid on finding the weakest lens with which any vessels can

be seen is, that although the observer can see equally well through a stronger lens, he must use his own accommodation to do so, and will over-estimate the degree of myopia by just the amount of accommodation he uses. In mixed astigmatism, when the eye is approached quite near, the vessels at right angles to the hypermetropic meridian can be clearly seen, but can be seen as distinctly on the addition of a convex lens. The vessels at right angles to the myopic meridian are seen indistinctly or not at all, but are clearly visible through some concave lens. Suppose a vertical vessel to be still distinctly seen through a lens of + 2 D and not through a stronger one, a horizontal vessel through a lens of — 2 D and not through a weaker one, hypermetropia 2 D is present in the horizontal meridian and myopia 2 D in the vertical meridian, and the eye under examination has mixed astigmatism of 2 D + 2 D = 4 D.

Measurement by Keratoscopy.

Having ascertained the direction of the shadow, we proceed in exactly the same manner as in the measurement of hypermetropia and myopia. We shall, however, find that on placing before the examined eye lenses either —convex or concave—of greater and greater strength, one is arrived at which causes the shadow to move in a direction opposite to its previous movement in one meridian; whilst in the meridian at right angles the movement of the shadow is the same as before the addition of the lens. The strength of this lens subject to the subtraction of 1 D in a case of hypermetropia, and the addition of 1 D in a case of myopia, see p. 58, gives the degree of hypermetropia or myopia in the meridian in which the direction of the shadow is altered. Let us

suppose that in a vertical direction the movement of the shadow is against the rotation of the mirror, and is reversed by a convex lens of 2 D, then on subtracting 1 D for the over estimation which always occurs, we have vertical hypermetropia of 1 D. We then put stronger lenses before the eye until one has been found which reverses the movement of the shadow in a horizontal direction, suppose this to be a lens of 4 D on subtracting 1 D for over estimation, we have horizontal hypermetropia of 3 D. The difference between 3 D and 1 D expresses the degree of astigmatism; thus, we have in the case supposed hypermetropia 1 D, hypermetropic astigmatism 2 D; the case is one of compound hypermetropic astigmatism. Again, suppose that the direction of movement of the shadow in the vertical direction is the same as the rotation of the mirror, that the addition of a concave lens of 2 D makes it move against the rotation of the mirror; then, on adding 1 D for under estimation, we have myopia 3 D in the vertical meridian. In the horizontal direction a concave lens of 1 D makes the shadow move against the mirror, then on adding 1 D for under-estimation we have myopia 2 D in the horizontal meridian. The difference between 2 D and 3 D expresses the degree of astigmatism, and we have myopia 2 D with myopic astigmatism of 1 D. The case is one of compound myopic astigmatism. In a case of mixed astigmatism it will be found that in one direction, the vertical for instance, the movement of the shadow is the same as the rotation of the mirror, whilst in the horizontal direction the movement is against the rotation of the mirror; that the addition of a concave lens will cause the shadow to move against the rotation of the mirror in the vertical direction, and the addition of a convex lens will cause the shadow to move in the same direction as the rotation of the mirror in the hori-

zontal direction; then, on making the necessary addition of 1 D to the concave lens, and subtraction of 1 D from the convex lens, we shall arrive at the degree of myopia in the vertical meridian and the degree of hypermetropia in the horizontal meridian; and the sum of the two will give the degree of astigmatism. Suppose that —2 D reverses the movement of the shadow in the vertical direction, we have myopia 3 D in the vertical meridian, and that + 2 D reverses the movement in the horizontal direction, we have hypermetropia 1 D in the horizontal meridian, and there is mixed astigmatism of 3 D + 1 D = 4 D.

In a case of simple hypermetropic astigmatism the shadow moves against the rotation of the mirror in all directions; the addition of a convex lens of 1 D does not affect its movement; the addition of + 1·50 or + 2 D causes the shadow to move in the same direction as the rotation of the mirror in the emmetropic meridian (myopia above 1 D having been produced), though it still moves against the rotation of the mirror in the direction of the hypermetropic meridian. If stronger lenses are added, one will be found which causes the shadow to move in the same direction as the rotation of the mirror, the strength of this lens subject to the subtraction of 1 D for over estimation gives the degree of hypermetropia in the hypermetropic meridian. Suppose that a lens of + 3 D is that which first causes the shadow to move in the same direction as the rotation of the mirror, we have hypermetropia 3 D — 1 D = 2 D: simple hypermetropic astigmatism 2 D.

In a case of simple myopic astigmatism above 1 D, the shadow moves in the same direction as the rotation of the mirror in the myopic meridian. In the emmetropic meridian the shadow moves against the rotation of the mirror. On the addition of concave lenses, one

is at length found which causes the shadow to move against the rotation of the mirror in the myopic meridian as well as in the emmetropic, the strength of this lens with the addition of 1 D for under estimation, gives the degree of myopia in the myopic meridian.

Suppose that a lens of 1 D is that which first makes the shadow move against the rotation of the mirror; we have myopia in the corresponding meridian, not of 1 D, but 1 D + 1 D = 2 D, or simple myopic astigmatism of 2 D.

Treatment.—The treatment of astigmatism consists in prescribing glasses which neutralise the defect. The optician should be furnished with the number of D of the required simple cylindrical lens in the case of simple astigmatism; and with the number of D of the required spherical and cylindrical lenses in the case of compound astigmatism: these are combined in one lens, of which one surface is ground to the required spherical curvature, and the opposite surface of the required cylindrical curvature; such a combination is known as a spherico-cylindrical lens. Opticians provide cards on which a diagram marked in degrees is printed, and on which the direction of the axis of the required cylindrical lens may be marked, or the lenses may be seen and adjusted by the surgeon himself, in which case they are sent for approval in a trial frame, in the rings of which they can be rotated, and, when the proper direction of the axis has been ascertained, fixed by turning a screw. In the case of mixed astigmatism, a bicylindrical lens—that is, a lens having one surface ground with a concave cylindrical curvature, the other with the requisite convex cylindrical curvature, the axes of the two at right angles to each other—may be ordered. Or what is preferable, a lens having on one surface a convex spherical curvature may have its opposite surface

ground with a concave cylindrical curvature, the strength of this, of course, being increased in proportion as the convex spherical surface increases the myopia in the meridian on which it (the cylindrical lens) is alone intended to act. For instance, in a case where myopia of 2 D exists in the vertical meridian, and hypermetropia 2 D in the horizontal, a lens one surface of which has a spherical convex curvature of 2 D may be used; but this, of course, increases the myopia in the vertical meridian by 2 D; consequently the other surface of the glass must be ground with a concave cylindrical curve of 2 D + 2 D or 4 D, so as to neutralise the myopia already existing, and that produced by the spherical convex curvature.

In some cases of mixed astigmatism it may be requisite to give glasses which enable the patient to see at a certain definite distance. Thus, in the case supposed above, with M 2 D in the vertical meridian and H 2 D in the horizontal, it might be desirable to bring the farthest point of distinct vision to 50 cm. (20 inches) this can be done by converting the 2 D of H into 2 D of M.

Now, a convex cylindrical lens of 2 D neutralises the hypermetropia, and renders the eye emmetropic in the meridian on which it acts. To induce a myopia of 2 D in this meridian, the curvature of the cylindrical lens must be increased by 2 D; consequently we shall have a convex cylindrical lens of 2 D + 2 D, that is 4 D; therefore, to make the hypermetropic meridian of 2 D myopic 2 D, a convex cylindrical lens of 4 D is required; and as M 2 D already existed in the vertical meridian we have by the addition of convex 4 D cylindrical converted mixed astigmatism into simple M of 2 D.

Patients suffering from astigmatism of whatever form should be strongly advised never to read or work without glasses. Their use for looking at distant objects is

more a convenience than a necessity, and in the lower degrees (below 1 D) may be omitted, but never in the higher. In cases of compound myopic astigmatism care must be taken that the spherical curvature is not too strong in the glasses which are used for reading; in fact the choice must be guided by the same rules as in simple myopia. The astigmatism should, however, always be fully corrected. In cases where the myopia in the least myopic meridian is not above 2·50 or 3 D, the astigmatism only should be corrected, the eye still being left with simple myopia of low degree. In cases where the myopia in the least myopic meridian is above 3 D a part of the myopia should be corrected; it is a good rule to order glasses which enable the patient to see clearly at about 55 cm. (twenty-two inches).

In cases of simple myopic astigmatism up to 1·50 D, especially in persons advanced in life, it is well to order for reading a convex cylindrical lens of the same strength as the concave cylindrical lens which corrects the astigmatism; but with its axis placed in a direction at right angles to that of the correcting concave lens; so that it acts on the emmetropic meridian and produces a myopia equal to that in the myopic meridian; in fact reduces the case to one of simple myopia of low degree.

Thus, if we find myopia 1·50 in the vertical meridian, and emmetropia in the horizontal, instead of giving a concave cylinder 1·50 D axis horizontal, leave the myopic meridian alone and order a convex cylindrical lens 1·50 D axis vertical.

Glasses may be ordered for distance which correct the whole of the myopia as well as the astigmatism except when the myopia is of very high degree (above 10 D) in which case it is well to leave about 1 D or 2 D of myopia still uncorrected.

In compound hypermetropic astigmatism the whole of

the Hm, or if necessary, both Hm and Hl as well as the As should be neutralised, and the glasses will do equally well for distance or near work; but if the patient has become presbyopic, the spherical curvature will have to be increased for reading, (see p. 80). When cases of astigmatism have been worked out under atropine, and when the power of accommodation returns concave glasses may not be quite strong enough whilst convex are rather too strong; a little perseverance will usually overcome the difficulty, if not, the concave curvature may be slightly increased or the convex slightly reduced.

CHAPTER V.

Diseases and Injuries of the Eyeball and its Appendages.

Many of the more important affections of the eyeball and parts adjacent can only be remedied by operation; the present section includes those forms of disease and injury which with a few exceptions (*e.g.*, glaucoma), require only medical treatment.

Affections of the Ocular Muscles, External and Internal.

Affections of the ocular muscles may be divided into those of the external muscles, recti and obliqui, and those of the internal muscles, muscles of the iris and the ciliary muscle.

Muscular asthenopia signifies weakness of some of the external ocular muscles. For all practical purposes it is sufficient to consider the disease as affecting the internal recti, but at the same time we may remember that it is possible to get symptoms of asthenopia from imperfect action of the external, or even of the superior or inferior recti or the oblique muscles.

The symptoms of muscular asthenopia always manifest themselves when reading or doing near work; they are, pain in the eyes, headache, indistinct vision with a tendency to diplopia. We are told that the page of the book seems to widen out, the print to become

misty, and the lines mixed up; or inability to do near work for any length of time, without these symptoms appearing, is complained of.

If we tell the patient to fix some small object—the end of a pen or pencil—and then move it nearer the eyes, they become unsteady, and soon one or other diverges, double images resulting. The images are crossed, that of the right eye being to the left of that of the left eye, and *vice versâ*. If we cover one eye and direct the patient to fix an object situated at about ten inches with the other, we shall find that the covered eye diverges, and on removing the hand he will see double; the diplopia may be only momentary, by an effort the deviated eye can be made to fix the object, and we shall see it move inwards; but after looking steadfastly for a short time one or other eye will diverge.

Muscular asthenopia occurs in all conditions of refraction, but is perhaps most frequently met with in myopia.

The treatment of muscular asthenopia depends on the condition of refraction. In myopia the difficulty arises from the far point (r) being very near the eyes, and much convergence being necessary to make the visual lines meet at the required distance. All that is necessary is to give a pair of glasses which remove r to a distance at which convergence is easy. For example, if myopia 8 D is present, r lies at five inches* from the eye, at which distance it may be impossible to maintain convergence. If we order — 6 D to be used for reading, we reduce myopia to 2 D (8 D — 6 D = 2 D), and remove r to about twenty inches from the eyes, at which distance convergence is easy (see also p. 17).

In emmetropia and hypermetropia the symptoms are

* In myopia the furthest point of distinct vision lies at the negative focal length of the lens which corrects it. The negative focal length of a lens of 8 D is five inches, of a lens of 2 D twenty inches.

due—not as in myopia—to the necessity for excessive convergence, but to real weakness or insufficiency of the internal recti, rendering them incapable of maintaining convergence to the distance at which ordinary print can be read. Such cases are remedied by optical means. Our aim is to make rays of light appear to come from a point situated at a greater distance from the eyes than the object looked at, and so lessen the amount of convergence required. This can be done by the use of prisms, or lenses arranged so as to have a prismatic action.

The action of a prism is to displace objects seen through it towards its summit (see p. 3). Consequently if we place in front of the eyes a pair of prisms with their summits or edges outwards, any object looked at through them is displaced outwards and can be seen distinctly with convergence to a point further from the eyes than that at which the object is situated; the distance is greater as the angle of the prism is larger. A very convenient way of finding the strength of the prism required is to place before the patient's eyes at a distance of 10 inches a straight vertical line with a round black dot in its centre. He will probably see the line and the dot single. Then place before one eye a prism of 5°, edge upwards, two dots at once appear; if no asthenopia is present they will both appear to be situated on the same line, if muscular asthenopia is present, the upper dot—that belonging to the eye covered by the prism—will be seen situated on a separate line, to the further side of the lower dot, crossed diplopia is produced. If we take a weak prism and place it before the eye already covered by the first prism, but with its edge outwards instead of upwards, we shall find the upper dots come more nearly over the lower; we try stronger prisms until we arrive at one

which makes the dots stand directly over each other. This prism will quite correct the muscular asthenopia and greatly assist the weak internal recti. It is not necessary to test both eyes; the prism found as above gives all the correction necessary for the two, and we divide it between them. Thus suppose a prism of 6° held edge outwards causes the dots to stand directly one over the other on a continuous line, we order a prism of 3° edge outwards for each eye; these are placed in an ordinary spectacle frame and used for reading, etc. In a case of emmetropia this is all that is needed; if hypermetropia is present, or if the patient has become presbyopic, the required convex curvature must be ground on one surface of the prisms as found above; or the convex lenses which correct the hypermetropia or presbyopia may be "decentrated" inwards, *i.e.*, the optical centre of each lens instead of being in the middle of the ring of the spectacle frame is put close to its inner edge—only half a lens is used—by which means in addition to its action as a convex lens, it has that of a diverging prism.

Paralysis of External Ocular Muscles.

The external rectus (sixth nerve), the superior oblique (fourth nerve), may be paralysed separately; the internal inferior and superior recti, and the inferior oblique (third nerve) as a group, or the whole of the muscles may be palsied together (ophthalmoplegia externa).

The symptoms of paralysis of a single external ocular muscle, or group of muscles, are double vision, with more or less marked deviation of the eye in some directions and want of mobility in others.

The direction of deviation and the relative position of the two images will tell us which muscle or muscles are affected. The projection of the false image is always in the opposite direction to that of the deviation of the eye; thus, with deviation of the eye inwards from paralysis of the external rectus the image is projected outwards, and we get what is known as "homonymous diplopia." With deviation of the eye outwards, the image is projected inwards and stands on the further side of the image of the properly directed eye, producing "crossed diplopia."

In the following descriptions the right eye is always supposed to be that affected :—

Paralysis of right external rectus.—The eye deviates inwards, the patient goes about with his head rotated to the right, and looks to the left; if he puts his head straight, double images at once appear, and we notice a marked convergent squint of the right eye; if an attempt is made to follow an object moved from left to right the images get further and further apart as the object is moved further to the right. If we hold a piece of coloured glass before one eye we shall find that the image on that side is coloured, homonymous diplopia is present.

Paralysis of the superior oblique.—In paralysis of the superior oblique the deviation of the eye is not so noticeable, but is in a direction upwards and inwards. Double vision when looking downwards is the chief symptom. This is caused by the unbalanced action of the inferior rectus, which, unless counteracted by the superior oblique, drags the lower end of the vertical corneal meridian inwards and rotates its upper end outwards. The images are homonymous; the false one is at rather a lower level and rather nearer to the patient than the true one, towards which it leans at the top.

Paralysis of the superior oblique gives rise to great inconvenience; it causes uncertainty in walking, and especially in going down stairs, and interferes with almost all occupations. As soon as the patient looks above the horizontal median plain the false image disappears.

Paralysis of superior, internal, and inferior recti, inferior oblique, and levator palpebræ.—The upper lid droops and covers the eyeball; on raising it the eye is seen to turn outwards, diplopia occurs, the two images being side by side; if a piece of coloured glass is placed in front of the deviating eye the image to the left becomes coloured (crossed diplopia). In some cases the accommodation is paralysed and the pupil is dilated and fixed, in others no change is observable; in the cases in which the pupil is dilated the instillation of atropine causes further dilatation.

If an attempt is made to look inwards or downwards a distinct rotation of the cornea on an antero-posterior axis (unbalanced action of superior oblique) is noticed. If the sound eye is closed and the lid of the affected one raised, and the patient directed to walk, he flounders about in the most ludicrous fashion, the deviated eye giving him an erroneous impression of the position of the floor and objects in the room.

Paralysis of separate muscles of this group may be met with, but is of extremely rare occurrence.

Paralysis of all the external ocular muscles (ophthalmoplegia externa).—The upper lid is more or less drooped, the eye looks straight forward and has no movement in any direction.

Paralysis of Internal Ocular Muscles.

The three internal muscles are the sphincter of the pupil, dilator of the pupil and ciliary muscle. The sphincter of the pupil and ciliary muscle are supplied by the third nerve through the ciliary ganglion; the dilator of the pupil by the sympathetic, either through the ciliary ganglion or by branches which do not pass through it. **Paralysis may affect the iris alone.** The dilator may be paralysed (paralytic myosis) the pupil will be moderately contracted, being about the same size as the other in good light, in very bright light it will contract a little, but when shaded will not dilate to anything like the same extent as the other. Consequently in dull light the affected pupil is much smaller than that of the sound eye. Accommodation is not affected. This condition of pupil is common as a physiological change in old age, but it then affects both eyes equally. When it occurs in one only it may be caused by paralysis of the cervical sympathetic; it is met with in cases of thoracic aneurism causing severe compression of the sympathetic trunk. The reverse condition, dilatation from spasm of the dilator, due to irritation of the sympathetic in the neck or thorax may occur. The sphincter alone may be paralysed (paralytic mydriasis). The pupil is moderately dilated, and its action both reflex and associated entirely abolished. Complete paralysis of the iris both dilator and sphincter may occur (*iridoplegia.*) The pupil is of medium size, it is quite uninfluenced by variations of light, but may act during accommodation (associated action).

The ciliary muscle alone may be paralysed (*cycloplegia*). The range of accommodation is nil, the eye remaining adjusted for its far point, but the activity of

the pupil is unaffected. This condition is not unfrequently met with after diphtheria, but the paralysis is more often partial (paresis) than complete. When we speak of paralysis of accommodation we refer to nervous cases, and do not include the partial or complete loss of accommodation consequent on presbyopia.

The ciliary muscle and sphincter of the pupil may be paralysed as seen in cases of complete paralysis of the third nerve; the pupil is moderately dilated and fixed, and accommodation lost.

Paralysis of all internal muscles ophthalmoplegia interna.—All three internal muscles may be paralysed; the pupil is of medium size, the movements of the iris—both reflex and associated—are abolished, and accommodation is lost.

Causes of ocular paralysis.—If we exclude cases of orbital tumour, which are evident enough, and of which ocular paralysis is only one of many well-marked symptoms, we have left a very large majority of cases of paralysis of the external ocular muscles, or external and internal combined, in which there is nothing in the condition of the eyeball, or orbit to guide us to the seat of disease. Meningitis, morbid growths, or periostitis about the base of the skull are often the cause of ocular paralysis, and occasionally aneurism of the carotid in the cavernous sinus, fracture of the base of the skull, and cerebral hæmorrhage; but in all these cases the paralysis is seldom confined to one nerve.

Gumma of the trunk of a nerve is probably the commonest cause of single paralysis. Some cases are referred to cold and considered similar to the peripheral paralysis of the facial from the same cause; about this point, however, there is room for considerable doubt. Paralysis of one nerve, usually of short duration, is met with in the early stages of locomotor ataxy, often occur-

ring and passing off before any other symptom develops. Ophthalmoplegia externa comes on very slowly, taking many months for its full development; it indicates sclerotic changes in the nervous centres, generally of syphilitic origin.

The causes of internal paralysis are but little understood, syphilis or gout is often at the root of the evil, but the exact local lesions in the present state of our knowledge must remain doubtful.

Treatment of ocular paralysis.—The treatment may be summed up in a very few words. Iodide of potassium and mercury should be given internally, and blisters applied to the temples or behind the ears, with galvanism to the affected muscles.

With the exception of ophthalmoplegia externa or interna, the prognosis is good in recent cases of ocular paralysis; but in those of many months standing little improvement will result from treatment.

Nystagmus signifies a peculiar, involuntary, quivering motion of one or both eyes, dependent on rapid contraction of antagonistic pairs of muscles. The disease is usually developed in infancy, and is then associated with considerable impairment of vision arising from congenital cataract, opacity of the cornea after ophthalmia neonatorum, atrophy of choroid, etc. Nystagmus occurs in some nervous disorders as locomotor ataxy, and also in persons who work in cramped or unnatural positions in bad light, as those employed in mines, when it is described as "miner's nystagmus."

Treatment.—Nothing can be done to remedy nystagmus in the two first classes of cases; but miner's nystagmus may be entirely cured by removing the patient from his work and the administration of tonics.

Spasm of accommodation.—In many cases of anomaly of refraction and astigmatism a tonic or inter-

mittent contraction of the ciliary muscle is present, it often masks a considerable amount of hypermetropia and may at times make the hypermetropic eye appear to be myopic. If it exists with myopia the degree of short sight is increased.

Symptoms.—Severe and constant pain in the eyeballs and forehead, increased on any attempt to use the eyes, and associated with some anomaly of refraction (generally hypermetropia); inability to see either near or distant objects distinctly; these symptoms being modified or entirely removed by the use of a mydriatic.

Treatment.—Paralyse the accommodation by the constant use of atropine (gr. iv. of sulphate to ℥i. of water) or other mydriatic, and accurately neutralise any existing anomaly of refraction or astigmatism.

CHAPTER VI.

The Eyelids and Conjunctiva.

Congenital anomalies.—Absence of the eyelids; a failure of closure of the fœtal fissure, leaving a cleft in one or both lids (coloboma); ptosis, complete or partial; development of a third lid; pigment spots, moles, nævi, and warty growths, have all been occasionally met with.

Ulcers.—Simple ulcers, primary venereal sores (chancres), tertiary syphilitic and cancerous ulceration, are sometimes met with. The first three require to be treated on general medical principles; the last by operation, if the disease has not proceeded too far.

Phthiriasis.—The pediculus pubis (crab louse) is sometimes found amongst the eye-lashes close to the margin of the lids. The edges of the lids appear to be covered with scabs and crusts somewhat resembling tinea; on close examination the insects themselves will be discovered adhering closely to the margin of the lids, their eggs being attached to the lashes near their bases.

Treatment.—The daily use of some kind of mercurial preparation, none being better than the Ung. Hydrarg. Ammoniatum.

Paralysis of the obicularis muscle occurs in some cases of facial paralysis: there is inability to close the eye, the lower lid falls away from the globe, there is considerable collection of lachrymal secretion at the inner canthus, and constant watering of the eye consequent on the displacement of the lower tear punctum and want of the proper movements of the lids.

Treatment.—General medical treatment should be adopted.

Spasm of the orbicularis muscle may occur from long-continued intolerance of light, consequent on affections of the cornea.

Treatment must be directed against the corneal affection. (*See* Diseases of the Cornea).

Spontaneous twitching, more especially of the lower lid, popularly known as "live blood," is met with in some cases of hypermetropia, or in persons whose digestions are out of order; it is very probably a symptom of undue contraction of the ciliary muscle.

Treatment.—Correction of existing hypermetropia, instillation of atropine, and attention to the general health.

Acute inflammation of the eyelids may occur during or after acute diseases (measles, scarlatina, etc.), in the course of erysipelas, as the result of injuries, or in connection with severe inflammation of neighbouring parts, *e.g.*, purulent ophthalmia. The swelling and redness are usually considerable, and the eye cannot be opened; the inflammation generally ends in resolution, but may (especially if it result from measles, scarlatina, etc.), go on to the formation of abscess, or even to sloughing of the skin.

Treatment.—Locally, fomentations with hot water or decoction of poppy-heads; if an abscess forms it should be opened—preferably through the conjunctiva.

The patient's general health should also be attended to.

Stye (hordeolum) is a small red, and painful swelling situated on the outer surface of the lid near its margin, and consists in a circumscribed inflammation of the lid, dependent on morbid change in the Meibomian glands. Styes generally occur in weakly, delicate

persons; several may appear simultaneously, or there may be a succession of them; they give rise to considerable irritation, and are often extremely painful. The inflammation usually goes on to suppuration.

Treatment.—Fomentations, poultices, the administration of tonics, and good living. When pus has formed, the little tumours should be opened. Suppuration may be prevented by rubbing the red oxide of mercury ointment into the swellings as soon as they appear. Pulling out a lash in the centre of the stye may sometimes shorten its duration.

Tinea (ophthalmia tarsi blepharitis). Patients suffering from slight tinea present themselves with scurf attached to the margins of the lids; in the more severe forms with yellowish-brown, dry, and closely adhering crusts. The lashes are often scanty, many of them having fallen out.

On removing the crusts the margin of lid will be found ulcerated, fissured and easily bleeding. The disease consists in inflammation and ulceration in and about the follicles of the lashes; it runs a very chronic course, often lasting for years in spite of remedies. It occurs most commonly in delicate children and young adults. In old cases the margins of the lids are much thickened giving rise to redness and eversion of the lower lids with displacement of the tear puncta, and consequent watering of the eye. This condition is known as "lippitudo."

Treatment.—Slight cases can generally be cured by the use of a lotion containing 10 grs. of boracic acid to the ounce of water, applied three or four times a day, and of mild nitrate of mercury ointment (one part of the ordinary nitrate of mercury ointment to eleven of lard),*

* The ointments employed in the ophthalmic department at Guy's Hospital are now almost invariably prepared with vaseline instead of lard.

smeared along the margins of the lids night and morning.

The patient should be directed to remove all the crusts by bathing with warm water or a weak alkaline solution before applying the ointment. Iron or cod-liver oil, or the two combined should be given internally in delicate subjects.

More severe cases should be treated by pulling out the lashes and removing the scabs with forceps, and then applying solid nitrate of silver to the raw surface left.

In cases where the lower tear punctum has become everted the punctum and canaliculus must be slit up. (See Part II., Chapter II.).

Injuries.—Wounds of the eyelids, however extensive or ragged, should, after having been thoroughly cleansed, be brought accurately together; they will usually heal readily enough. Should there be any loss of substance, an endeavour must be made to prevent contraction of the resulting cicatrix causing distortion of the lids.

Ecchymosis of the lids (black eye) frequently occurs as the result of blows, and may be caused by leech-bites or operations, and occasionally as the result of strain as in whooping-cough.

Treatment.—Most cases may be left alone, but if it is desirable to get quickly rid of the effused blood, a cold poultice made of equal parts of the scraped root of black bryony and bread-crumbs should be applied. The poultice should be kept on as long as the patient can bear it. The application is often accompanied by a good deal of stinging pain.

Emphysema of the lids sometimes occurs from rupture of the mucous membrane of the nose, air being forced into the cellular tissue of the eyelids on sneezing

or blowing the nose. Gentle pressure with cotton-wool and a bandage, and avoidance of violent expiratory movements, sneezing, etc., is the only treatment required.

The lachrymal apparatus.—The principal affections of the tear passages, etc., will be described in Part II.

The Conjunctiva.

Ophthalmia.—This term includes all the different forms of inflammation of the conjunctiva. Certain characters are common to all: these are more or less vascularity of the membrane, uneasiness and stiffness of the lids, pain of a smarting character, some kind of discharge, and gumming together of the lids during sleep.

Inflammation of the conjunctiva has to be distinguished from inflammation of the sclerotic or subconjunctival fascia, and from the injection of these structures which is present in many of the inflammations of deeper parts of the globe. The distinction can be made by paying attention to the position of the vessels and the character of the pain. For position of vessels see Chapter II., p. 22, 23.

The pain in inflammation of the conjunctiva is of a smarting character; while in inflammations of deeper parts it is dull and aching, and often very severe.

Treatment.—Inflammations of the conjunctiva are as a rule best treated by weak astringent applications.

Any of the following formulæ may be employed :—

Antiseptic Astringent Lotion.

Boracic acid, gr. x to xv; water, or rose-water, ℥ j.

Useful in all forms of ophthalmia and in sloughy ulceration of the cornea.

Strong Alum Lotion with Boracic Acid.

Alum, gr. x.; boracic acid gr. x. to xx.; water, ℥ j.

Useful in cases of purulent ophthalmia.

Alum Lotion.

Alum, gr. iv. to vj.; water, ℥ j.

Sulphate of Copper Drops.

Sulphate of copper, gr. ij.; water, ℥ j.

Sulphate of Zinc Drops.

Sulphate of zinc, gr. ij.; water, ℥ j.

Nitrate of Silver Drops.

Nitrate of silver, gr. j.; water, ℥ j.

Chloride of Zinc Drops.

Chloride of zinc, gr. ij.; water, ℥ j.

Most useful in cases of chronic ophthalmia.

Atropine and Astringent solution.

Sulphate of atropia, gr. $\frac{1}{2}$ to gr. ij.; sulphate or chloride of zinc, gr. ij.; water, ℥ j.

Useful in cases where iritis or corneitis occurs in the course of ophthalmia.

Any of these remedies may be given to the patient to use himself; they should be applied from three to six times a day, or oftener, and the patient should be directed to wash away all discharge before using any of them, and to take care that the lotion goes well between the lids, and is brought thoroughly into contact with the conjunctiva.

Some kind of ointment (spermaceti, mild nitrate of mercury, etc.) should also be ordered to be smeared on the margins of the lids at night, to prevent their becoming gummed together during sleep.

The condition of the patient's general health should also be attended to.

Other applications, which should be used by the surgeon himself, are:—

The mitigated nitrate of silver stick (consisting of nitrate

of potash and nitrate of silver, in the proportion of three parts of the former to one of the latter); *green stone, lapis divinus,* (consisting of equal parts of alum, nitrate of potash, and sulphate of copper, with a small quantity of camphor), and *solid nitrate of silver.* In order to apply any of these the patient should be seated in a chair, and the surgeon standing behind, as in Fig. 31, should evert the lids and lightly rub their conjunctival surface with either. If a preparation of nitrate of silver be employed, the conjunctiva should be washed with salt and water immediately after the application.

VARIETIES OF OPHTHALMIA.

Catarrhal ophthalmia is commonly caused by draughts of cold air, is highly contagious, and acute in its course.

The conjunctiva, both ocular and palpebral, is highly injected, and sometimes swollen; there may be small extravasations of blood in the former, and there is a thick yellow, tenacious discharge.

One or both eyes may be affected, the disease usually commences in one and spreads to the other in the course of two or three days.

Treatment.—In the early stages (before there is any amount of discharge) some soothing application (as decoction of poppy-heads) should be employed; later on, an astringent, boracic acid lotion, alum lotion, or alum and boracic acid lotions in equal parts, should be used three times a day, and some mild nitrate of mercury or spermaceti ointment smeared on the edges of the lids at bed-time, to prevent their becoming gummed together during sleep.

The patient (or, in the case of a child, those who have

the care of it), should be warned of the contagious nature of the disease, and no sponges, towels, etc., which he is in the habit of using, should be used by other people. Among the poorer classes it is very common to see a whole family suffering from catarrhal ophthalmia.

Muco-purulent ophthalmia.—A troublesome form of conjunctival inflammation accompanied by profuse muco-purulent discharge, swelling and redness of the eyelids, and often intolerance of light due to slight corneal ulceration, is frequently met with in children recovering from measles, scarlatina, etc. The patients are often extremely feverish and irritable.

Treatment.—Solution of atropine (gr. iv. to ℥j. of sulphate) should be dropped into the eyes by the surgeon himself, once or twice a week, boracic acid lotion used three to six times a day or oftener; yellow oxide of mercury ointment (see p. 120), put into the eyes at night; the bowels freely opened by a powder of calomel and rhubarb, or other aperient, repeated on alternate nights for a week, and directions given as to the child's feeding. When the bowels have been well cleared out iron or other tonic should be prescribed.

Chronic ophthalmia is usually a sequel of some more acute form; the palpebral conjunctiva is reddened, and the ocular conjunctiva presents patches of slightly increase vascularity, but no general redness, as in catarrhal ophthalmia; the lids are often somewhat thickened, and the caruncle and semilunar fold swollen. There is slight mucous discharge, which forms dry crusts on the margins of the lids, and at the inner canthus; overflow of tears may occur from obstruction or displacement of the tear puncta.

Treatment the same as that of catarrhal ophthalmia. The disease may continue for almost any time, and when one remedy appears to have lost its effect another

should be tried. Boracic acid lotion is most useful in some cases, chloride of zinc in others.

In all obstinate cases the existence of some anomaly of refraction must be remembered and looked for (*see* p. 61). Lotions will do no good so long as hypermetropia or astigmatism remains uncorrected.

Phlyctenular ophthalmia, usually met with in children and young adults, especially females, is characterised by the existence of small whitish elevations on the conjunctiva, most commonly near the margin of the cornea; each little elevation has a wisp of blood-vessels leading to it if near the corneal margin, and is surrounded by a zone of vascularity if situated in any other part of the conjunctiva. There is some watering of the eye and slight mucous discharge.

Patients are frequently met with who suffer from repeated attacks of phlyctenular ophthalmia; in such some anomaly of refraction is nearly always present.

Treatment.—In treating phlyctenular ophthalmia our object is to set up a certain amount of irritation of the conjunctiva, by which the phlyctenulæ will be destroyed. This can be attained by dusting calomel into the eye daily, or by ordering a small quantity of an ointment containing 2 grs. of yellow oxide of mercury to ʒj. of lard or vaseline, to be applied to the inner surface of the lower lid at bedtime. Either of these remedies will soon cause the phlyctenulæ to disappear. Tonics should be given if required. The refraction must always be carefully tested in all obstinate or recurrent cases. The disease, as affecting the conjunctiva covering the cornea, will be spoken of under diseases of that structure.

Granular ophthalmia.—This disease occurs at all ages, and is very common amongst the lower classes, especially the Irish; it is highly contagious. Granular ophthalmia is often very prevalent where large numbers

of persons are crowded together in workhouses, parish schools, barracks, etc. It would appear that in those who have lived for a considerable time under unfavourable hygienic conditions, a peculiar granular state of the palpebral conjunctiva becomes developed. Persons thus affected are said to be predisposed to granular ophthalmia. The predisposed eyelid is characterised by the existence of small pale spherical bodies, situated in the structure of the conjunctiva; the little bodies much resemble and are known as sago grains, and are most constantly found upon the lower lid near the outer canthus.

This predisposed or granular condition of the eyelids may remain stationary for an unlimited time without giving rise to inconvenience; but on the other hand, attacks of inflammation are ever liable to be set up, giving rise to the development of granular ophthalmia as seen in practice.

We meet with three principal forms of granular ophthalmia, which may be distinguished from each other by the nature of the granulations present.

One characterised by the predominance of the sago grains already alluded to, around which inflammation has been set up, is known as *follicular granulation.*

Another form, characterised by the predominance of hypertrophied papillæ, by which the sago grains if they exist are obscured, is known as *papillary granulation.* A third form, characterised by a mixture of follicular granulations and hypertrophied papillæ, is known as *mixed granulation;* this is the most severe form of the three.

In old cases, and especially in those that have been treated by strong caustics, the conjunctiva may be found converted into a mass of rough hard cicatrices, and its secreting power destroyed, the condition known as

"*xerophthalmia*" being developed. A condition resembling xerophthalmia and closely allied to, if not identical with it, is described as "essential shrinking of the conjunctiva" and is said to be preceded by an eruption of pompholyx upon the conjunctival surface.

Granulations in active granular ophthalmia, unlike the sago grains which characterise the predisposed lid, are always found most developed on the conjunctiva covering the attached border of the tarsal cartilage of the upper lid. Their appearance is more or less altered by treatment; they are accompanied by thick yellow discharge, and there may be more or less severe intolerance of light.

Sequelæ of granular ophthalmia.—The cornea may become more or less opaque and vascular, especially at its upper part, a condition known as "pannus," and caused by constant irritation of the cornea by the rough surface of the lid. Corneal ulceration or iritis may also occur.

The conjunctiva may be destroyed to a greater or less degree, extensive cicatrices being formed, which, by their contraction, cause shrinking of the membrane and distortion of the lids, with entropion and narrowing of the palpebral aperture. The hair bulbs may become displaced, causing the eyelashes to be misdirected (*trichiasis*) (see Part II., Chapter II.). The results of granular ophthalmia are frequently aggravated by unskilful treatment.

Treatment.—In treating granular ophthalmia our object is to destroy the granulations, with as little damage as possibly to the conjunctiva itself.

The use of strong caustics must be carefully avoided, as they cause too much destruction of tissue, followed by the formation of contracting cicatrices.

Slight cases can be cured in a short time by the

application of mitigated nitrate of silver stick twice a week, or oftener, and the use of sulphate of copper drops from three to six times a day.

More severe cases will remain under treatment for months or years, and will tax the surgeon's ingenuity and patience to the utmost, but if persevered with will improve greatly and may ultimately recover. If the ophthalmia is of recent date the granulations should be touched every day with the mitigated nitrate of silver stick, and sulphate of copper drops used from three to six times daily.

In chronic cases the green stone should be used instead of the nitrate of silver stick.

The application of calomel powder or quinine to the granulations has also been found useful in some cases.

In cases where there is much photophobia with pain, or if the cornea be ulcerated, or iritis present, hot sedative fomentations should be employed five or six times a day, and solution of atropine gr. 1 to ℥j, dropped into the eye three times a day, until the more acute symptoms have passed off, when the caustic treatment can be commenced.

When the cornea is completely opaque and fleshy looking, inoculation with pus from a case of purulent ophthalmia may be tried, but only in extreme cases, otherwise we may do more harm than good by causing sloughing of the cornea; should but one eye be affected, care must be taken to prevent the other becoming inoculated.

In some case of old-standing granular ophthalmia where the granulations are rough and pale, and there is considerable pannus, much good may be done by setting up a purulent ophthalmia by the application of an infusion of the seeds of *Abrus precatorius*—jequirity

seeds—commonly known as crab's eyes. The infusion should be prepared thus:—

Jequirity seeds, free from husks .	gr. 70
Distilled water	℥ iij.

Soak bruised grains in the water for two hours, then pound up and re-soak in the same water for 22 hours, then filter.

The infusion should be applied by everting the lids and brushing it freely over them and well into the fornix with a camel-hair brush.

The effect produced is, that within five or six hours sharp conjunctivitis sets in, followed in six hours more by the formation of a membrane over the conjunctiva, both ocular and palpebral, with pain, swelling, photophobia, watering and abundant muco-purulent discharge. The inflammation remains at its height for about twelve hours, and then begins to subside, it can be reproduced by a further application of the infusion. If the desired effect is not produced by one application, as many more may be made as necessary.

Pannus as a rule requires no special treatment, and if not very dense, disappears as the granulations are cured, but in cases where it is dense and does not disappear with the granulations, improvement may follow the operation of peritomy or deep cauterization around the corneal margin with the actual cautery. In all cases some simple ointment should be applied to the edges of the lids at night, to prevent their becoming gummed together.

Purulent ophthalmia.—Purulent ophthalmia may be met with, as "ophthalmia neonatorum" in children, soon after birth, or in older persons. In the former case it is caused by contact of acrid vaginal secretions, by want of cleanliness and fresh air, or a combination of the two; in the latter by contact with some form

of specific pus, or by constant irritation of the already inflamed conjunctiva. It is highly contagious.

The worst form of the disease, whether occurring in infants or older persons, is that caused by inoculation with gonorrhœal matter "gonorrhœal ophthalmia."

"Ophthalmia neonatorum" makes its appearance a few days after birth; the eyelids are found red or bluish-red and swollen; the eyes can only be opened with difficulty, and on attempting to separate the lids, thick yellow purulent discharge escapes from between their edges; both eyes are almost always affected.

Purulent ophthalmia in older persons may affect one or both eyes; it commences with intolerance of light, lachrymation, and injection of the conjunctiva, at first much resembling an ordinary attack of catarrhal ophthalmia, but in about twelve to twenty-four hours its real nature becomes apparent by thick yellow discharge from between the swollen, red, and sometimes everted lids. The conjunctiva is bright scarlet, traversed by large distended blood-vessels, and much swollen, especially the ocular portion *(chemosis)* which may overlap the cornea, and protrude in folds between the lids; there is pain and intolerance of light; and there may be much general depression, especially if the attack has lasted long. The patient may be suffering from gonorrhœa. The great danger to be feared in purulent ophthalmia is implication of the cornea, which may be partially or entirely destroyed by suppuration or sloughing.

Treatment.—In all cases the patients themselves or their parents should be warned of the contagious nature of the disease, and if one eye only be affected, the greatest care should be taken to protect the other. This may be done in children by careful bandaging of the unaffected eye; in grown up persons by the application over the sound eye of what is known as a "Buller's

shield," *i.e.*, a watch glass fixed in the centre of a piece of thin india-rubber sheeting, cut to the required size and secured by strapping. If possible, a good view of the cornea should be obtained, as its condition materially influences the prognosis with regard to sight. The examination should be made with care, as the cornea may be ruptured whilst making it.

In ophthalmia neonatorum the only treatment required is to wash out the eyes every hour or half-hour with equal parts of strong alum and boracic acid lotions until the discharge is lessened; the lotion need only be used thus frequently for twelve hours out of twenty-four (from 8 a.m. to 8 p.m.), the child being allowed to sleep at night; as the discharge gets less the lotion may be used less frequently. Some simple ointment should be applied to the margin of the lids once or twice a day to keep them from sticking together. The greatest attention must be paid to cleanliness.

Slight cases of purulent ophthalmia in older persons may be treated in the same manner, but the more severe forms (especially the gonorrhœal) require much more energetic measures.

The treatment should be both local and constitutional.

Local treatment.—When the patient is first seen the lids should be everted, and the whole conjunctiva, brushed over with a stick of solid nitrate of silver, or painted with a solution of forty to sixty grains of the salt to ℥j of water; the application should be repeated in the course of two or three days if no improvement has taken place. The patient should be kept lying in a subdued light, and a bag of ice, or lint kept wetted with ice water, applied over the closed lids; the ice or lint should be removed and the eyes washed out every hour or half-hour with some astringent or antiseptic lotion,

the greatest cleanliness being observed. Another and extremely efficacious plan of treatment is, having thoroughly cleansed the eye from discharge, to fill the conjunctival sac, with an ointment of hyd. ox. flav., gr.xvi., acid. borici., gr. x., atropiæ sulph., gr. ii., cocaine hydrochlor., gr. x., vaseline, ℥ i. The ointment may be applied with a brush, syringe, or quill; it does not matter how, so long as the conjunctiva is thoroughly coated with it. The eye should then be covered with a piece of lint smeared with the ointment and lightly bandaged. A fresh cleansing and application of the ointment is required every four hours or oftener according to the amount of discharge. As soon as the swelling has subsided, and the discharge become sensibly lessened, the ointment may be discontinued and washing with boracic acid lotion substituted. Whatever form of local treatment is adopted the great point is *never to allow discharge to collect.*

Should there be much pain, and the patient strong, blood may be taken from the temples by leeches or the application of the artificial leech, but, as before stated, most patients suffering from severe purulent ophthalmia are much depressed, and will not bear depletion. If there is great swelling, pressure on the cornea may be lessened by freely dividing the outer canthus, with a strong pair of scissors or scalpel.

Constitutional Treatment.—A good purge should be given, followed by the free administration of tonics, especially iron and quinine, with good living, and a fair amount of stimulants.

If perforation of the cornea threaten or has taken place, the eye should be kept firmly bandaged, so as to prevent as much as possible any escape of the contents of the globe.

Diphtheritic ophthalmia.—This form of ophthal-

mia is but rarely met with in London; it affects persons of all ages. At first sight the case appears to be one of severe purulent ophthalmia; its chief characteristic, however, is a solid infiltration of the substance of the conjunctiva, with or without the formation of diphtheritic membranes on its surface. The affected eye is frequently lost from implication of the cornea. The disease is best treated by sedative and antiseptic applications, as fomentations of poppy-heads, or belladonna mixed with boracic acid, attention being also paid to the patient's general health.

Membranous ophthalmia is more commonly met with than the foregoing. It looks at first sight like a case of moderately severe purulent ophthalmia, but on closer examination the characteristic yellowish membrane will be found adhering closely to the palpebral conjunctiva, from which it can be separated, leaving an abraded and bleeding surface. Membranous ophthalmia differs from true diphtheritic ophthalmia by the absence of the solid infiltration.

The treatment is the same as that of diphtheritic ophthalmia.

Ulcers.—Simple ulceration of the conjunctiva is rare, syphilitic sores are occasionally met with, cancerous ulceration is mentioned in Part II., Chapter II.

Injuries.—Wounds of the conjunctiva usually heal readily enough, requiring only simple treatment.

Burns are usually caused by contact of lime or hot metals; the damage done may be only slight, or the whole conjunctiva and cornea may be converted into a dead white slough.

Treatment.—The conjunctiva should be carefully examined, and all foreign bodies and portions of sloughy tissue removed; should the injury have been caused by lime the surface of the conjunctiva must be carefully

cleansed with a weak solution of acetic acid or simple warm water. Some oil should be placed between the lids, and the eye bound up with wet lint and a bandage. If any symptoms of iritis appear, a solution of atropine should be dropped into the eye from three to six times a day. Should there be much discharge boracic acid or other astringent lotion may be used. Should there be much pain a two to four per cent. solution of hydrochlorate of cocaine should be dropped into the eye five or six times a day.

When the sloughs have separated, care must be taken to prevent adhesions between the raw surfaces left, by passing a probe between the lids and eyeball once or twice a day, and directing the patient to draw the lid away from the globe frequently.

Foreign bodies.—Small pieces of coal, iron, etc., are sometimes found embedded in the conjunctiva, and must be removed.

Hæmorrhage into the substance of the conjunctiva or beneath it may occur spontaneously, or from injury; no treatment is necessary; the patient may be assured that no harm will come of it, and that the blood will disappear in the course of a week or longer.

CHAPTER VII.

The Cornea, Sclerotic, Episcleral Tissue, and Lens

The Cornea.

Inflammation of the cornea (corneitis or keratitis). **Symptoms.**—Corneitis is characterised by watering of the eye, impairment of vision, intolerance of light, and pain, at times severe, at others insignificant; on examination, more or less of the cornea will be found cloudy or quite opaque, and blood-vessels may be seen in its substance or on its surface.

It is of importance to notice the course and position of the blood-vessels in any case where the cornea has become vascular. Should the vessels lie altogether in the cornea, commencing near its margin, and passing for a variable distance in its substance, the case is probably one of interstitial keratitis; but should the vessels be continuous with those of the conjunctiva, pass over the margin of the cornea, and lie superficially on its surface, the vascularity is probably due to mechanical irritation from granular lids or inverted lashes, and the condition known as *pannus* is present.

It is very necessary that the difference between these two forms of vascularity should be recognised, as their treatment varies widely.

In the former case the treatment of keratitis, to be presently described, should be adopted; in the latter, treatment must be directed against the cause of the vascularity (granular lids, etc.).

Corneitis may be simple, when it probably arises from some local cause, it may depend on some constitu-

tional taint as congenital syphilis; or may merely be a symptom of a delicate state of the system.

Simple corneitis may be caused by injuries, or the lodgment of foreign bodies on the surface or in the substance of the cornea. There is some pain, intolerance of light, and lachrymation, and some part of the cornea is found occupied by a halo of dulness.

Interstitial or parenchymatous keratitis (corneo-iritis, syphilitic keratitis, keratitis, diffuse keratitis, vascular corneitis).

Interstitial keratitis occurs as a rule in persons who are affected by hereditary syphilis; it is frequently, but by no means invariably, associated with changes in the teeth, pegged canines, notched incisors, or dome-shaped first molars; flattened nose, fissures around the angles of the mouth, or other manifestations of congenital syphilis. In some cases injury seems to be the determining cause of this form of keratitis.

It usually first makes its appearance between the fifth and eighteenth years, but has been seen as late as the thirtieth; it always affects both eyes, either simultaneously or at short intervals; it runs a very chronic course and is most intractable, a severe attack often lasting from twelve to eighteen months. Relapses are frequent, and occasionally recurrences occur.

Symptoms.—Interstitial keratitis presents all the symptoms of inflammation of the cornea in a marked degree. The opacity is peculiar, and is caused by infiltration of the substance of the cornea with opaque material.

At first the cornea becomes spotted in its centre, but the spots soon run together, forming a greyish haze; opacity then commences at the upper and lower corneal margins, and gradually spreads, until the whole structure resembles somewhat a piece of ground glass,

apparently blood-stained in parts, from the development of innumerable minute blood-vessels. There is always a well-marked band of ciliary injection. Interstitial keratitis is not unfrequently complicated by iritis, hence the name "corneo-iritis."

The opacity having reached a certain point, may remain stationary for months, but at length clearing commences, and the cornea regains more or less of its normal transparency, recovery always taking place to a much greater extent then would be at first expected. When the cornea has sufficiently cleared to allow an examination of the fundus to be made, spots of atrophy and masses of pigment in the choroid are frequently seen, showing that "choroiditis disseminata" has existed along with the corneitis. In some few cases a choroido-iritis is set up, the eye becomes enlarged, its anterior portion bulging forwards; the ciliary region becomes stretched and thinned and appears dusky in colour, and the tension of the globe is increased. In other cases the eye becomes soft and eventually shrinks. The subjects of interstitial keratitis often become quite deaf from syphilitic affection of the tympanic membrane, or internal ear.

A form of interstitial keratitis characterised by the existence of intense congestion at the margin of the cornea with swelling of the congested portion is sometimes described as "marginal keratitis." The vessels are more superficial and the congestion is of a brighter red than in ordinary interstitial keratitis. The vessels are continuous with the superficial loop plexus of the corneal margin (*see* Fig. 16, p. 22.)

Pustular corneitis (phlyctenular, strumous, vascular corneitis; strumous ophthalmia, fascicular keratitis).

Pustular corneitis is met with in children and young adults; it often follows measles, scarlatina, and other

acute diseases; it is frequently accompanied by eczematous eruptions on the eyelids, about the nostrils and angles of the mouth, and on the head, the patients often present well-marked strumous diathesis, and are generally said to be delicate.

Symptoms.—In most cases there is profuse lachrymation, accompanied by great intolerance of light; the lids may be swollen, covered with eczematous eruption, and tightly screwed up, so as to cause the greatest difficulty in examination.

There is more or less injection of the ciliary region (ciliary redness). Upon the surface of the cornea may be found (1) small greyish elevations (phlyctenulæ); (2) phlyctenulæ in a state of suppuration (pustules); (3) small ulcers left on discharge of the contents of the latter. Any of these are usually found in greatest quantity round the margin of the cornea, but its whole surface may be found dotted over with phlyctenulæ, pustules, or ulcers; or examples of all three may be met with in the same eye. There is more or less haziness and vascularity surrounding the affected portions of cornea, and in some cases there is thick mucous or muco-purulent discharge in addition to the lachrymation.

Cases of pustular corneitis, accompanied by great intolerance of light, much swelling of the eyelids, profuse lachrymation, and thick muco-purulent discharge, occurring in strumous children, are sometimes described as a separate disease under the name of "strumous ophthalmia." See also muco-purulent ophthalmia.

Pustular corneitis is very likely to recur.

Fascicular keratitis is a somewhat rare form of the disease characterised by the existence of a fasciculus of vessels running on to the cornea from its margin, the fasciculus terminating in a small ulcer, phlyctenula, pustule, or small inflamed patch of cornea.

Keratitis punctata occurs as a rule in women from about 25 to 40 years of age; but may be met with in both sexes at all ages, as a part of sympathetic ophthalmia; it much resembles the early stages of interstitial keratitis, and when not a part of sympathetic ophthalmia is probably due to acquired syphilis; as a rule, one eye only is affected; there are the usual symptoms of corneitis, but the intolerance of light is not very severe; the cornea is dotted over with small greyish opacities (looking as if sand had been rubbed into its structure), which are collected most thickly in its central and lower portions, often forming a triangular patch with its base downward. On careful examination the spots will be found to occupy the posterior layers of the cornea. This disease is most intractable, and may be accompanied by iritis and in some cases by increased tension of the eye-ball.

Corneitis with sloughing or suppuration is usually the result of sharp blows, as flicks from twigs, etc., or is caused by the irritation of foreign bodies, as the husks of corn; it may also occur after operations for cataract, and sometimes arises spontaneously in badly nourished persons, especially those suffering from chronic muco-purulent discharge from the lachrymal sac.

Symptoms.—Those of corneitis—severe pain being, as a rule, one of the most marked; some part of the cornea will be found occupied by a collection of pus, part of which may have escaped into the anterior chamber and collected at its lower part, giving rise to the condition known as "hypopyon;" or the pus may have gravitated down between the layers of the cornea to its lower margin, forming a collection much resembling hypopyon, and known as "onyx." Suppurative corneitis is met with in cases of *neuro-paralytic ophthalmia,* a peculiar form of inflammation, associated with paralysis of the

ophthalmic division of the fifth nerve, and consequent anæsthesia of the parts supplied by it.

Instead of a collection of pus, some part of the cornea may be found occupied by a dead white slough, or a large ulcerated and sloughing surface.

The iris may also be inflamed and suppurating.

Frontal herpes.—Corneitis with ulceration, often associated with severe iritis, occurs in conjunction with swelling of the eyelids and conjunctivitis in cases of frontal herpes and is not unfrequently mistaken for erysipelas. In some cases perforation of the cornea occurs and irreparable damage is done, or the eye may be entirely lost from the combined effects of corneal and iritic inflammation.

Treatment.—The treatment of corneitis should be both local and constitutional.

Local treatment.—All foreign bodies or other sources of irritation should be removed, and the eyes protected from light by a large shade, protectors, or a bandage. Sedative applications should be employed, none being better than belladonna lotion, containing from gr. vi. to x. of extract of belladonna to one ounce of water; or, if preferred, a weak solution of atropine, gr. i. to a pint of water, may be used instead; the eyes should be bathed three or four times a day with either of these.

In pustular corneitis, unless there is great intolerance of light, the yellow oxide of mercury ointment combined with atropine, (gr. $\frac{1}{10}$ or $\frac{1}{5}$ of sulphate of atropine, gr. ij. of yellow oxide of mercury, ʒ j. of vaseline), should be applied to the inner surface of the lower eyelids at bed-time.

If iritis exists, a solution of atropine, gr. $\frac{1}{2}$ to gr. ij. or iv. to the ounce of water, should be dropped into the eyes as often as may appear necessary.

In corneitis with suppuration warm applications will be found most beneficial; the eye should be well bathed with warm belladonna lotion or decoction of poppies several times a day, and bound up firmly with lint, soaked in one or the other. Dry heat is often of great use. It can be best applied by means of a metal coil (Leiter's) made for the purpose, through which a stream of hot water passes. A piece of lint should be laid over the closed lids and the coil bandaged over it. The application may be continued for fifteen or twenty minutes several times a day. If the coil cannot be obtained, dry heat may be applied by the use of large pads of cotton-wool heated before a fire. The eye may be kept bandaged with pads of wool, instead of lint, soaked in the sedative solutions. If pain is a prominent symptom it may be greatly relieved by the application of heat and also by taking blood from the temples. Should a large area of the cornea become infiltrated with pus, a free incision should be made by transfixing with a cataract knife, and cutting out obliquely through the centre of the infiltrated portion.

In cases of corneitis, especially of the pustular form, where there is obstinate intolerance of light, and the disease constantly relapses or recurs, in spite of other treatment, a seton should be placed in the skin of the temple on one or both sides (see Part II.). In some cases the spasmodic contraction of the obicularis may be kept up by the irritation of small fissures at the outer canthus; in such a free division of the junction of the lids and obicularis by cutting through the outer canthus will often effect a speedy cure.

The inhalation of chloroform is also said to act beneficially in some cases.

If in a case of suppuration or sloughing, perforation of the cornea appears imminent or tension becomes increased, iridectomy should be performed (see Part II.).

Constitutional treatment.—Simple corneitis requires no constitutional treatment. In the interstitial and punctate forms, antisyphilitic remedies should be employed; to young children hyd. cum cret., gr. j. to iij. three times a day should be given; to older patients the bichloride of mercury in doses of one-sixteenth to one-twelfth of a grain combined with bark or other tonic.

The other forms of corneitis, especially the pustular, are best treated by the administration of tonics, as steel wine, dialised iron, tincture of perchloride of iron, quinine, etc.; and in strumous children, cod-liver oil should also be prescribed, with good living and plenty of fresh air.

Ulcers of the cornea present a great variety of forms and are sometimes described as marginal or central, according to their position. They may be transparent or opaque, healing, indolent, vascular, or sloughing. The depth to which the corneal tissue is destroyed varies from slight abrasion of its surface to destruction of its whole thickness, causing perforation. The area of the cornea which is destroyed also varies from a small point to its whole surface.

Ulceration of the cornea is constantly met with in cases of debility, from whatever cause arising. It is very common in patients recovering from acute diseases, as measles, scarlatina, and more especially small-pox, not from the formation of pustules or eruption on the cornea but from impaired nutrition. Children are much more frequently affected than adults.

The symptoms of ulceration are very similar to those of corneitis. On examination any kind of ulceration may be found (one variety has been mentioned under pustular corneitis). There may be one or more small **transparent ulcers,** which can only be seen in certain lights, and are

very likely to be overlooked. They appear like small abrasions of the epithelium; sometimes the greater part of the surface of the cornea is found to be affected either by several small transparent ulcers or one large one. This form of ulceration is most commonly met with in adults of irritable, nervous temperament, and should always be carefully looked for when a patient of this description presents himself suffering from severe intolerance of light, watering of the eye, and smarting pain, without any very apparent cause. A small single central ulcer is very common in children.

Opaque ulcers are visible enough; they may be of any size; generally only one but occasionally two or three are seen in the same eye. At times they appear to be healing, when the edges are smooth and the surface of the ulcer rough and opaque or cloudy. At others they are indolent, and again they may be spreading, when their edges are clean cut, as if a piece of the cornea had been punched out by some sharp instrument; the surface of the ulcer appears glassy, and is often deeply excavated.

Sloughing ulcer is more or less opaque, spreads rapidly both in area and depth, and if the process is not soon arrested the cornea will be perforated, and a prolapse of the iris of greater or less extent (according to the size of the perforation) will take place. If the opening is large the lens or some of the vitreous may escape.

In the greater number of cases of perforation of the cornea the iris pushes forward, fills the opening, and becomes adherent to its margins, forming an "anterior synechia;" but a considerable prolapse may take place, forming a projection or bulge from the surface of the cornea (staphyloma).

Marginal or crescentic ulcer (ulcus corniæ serpens) is a somewhat peculiar form of corneal ulceration; it is

met with in persons of middle age, generally females, is very intractable, and very likely to recur and relapse. This form of ulceration is accompanied by very severe pain, great intolerance of light, and very profuse lachrymation. On examination a crescentic patch of ulceration is found skirting generally the upper margin of the cornea; the ulcer is deep, its margin clean cut, and its surface glassy-looking.

The ulceration spreads rapidly up to a certain point —remains stationary for a time, and then commences to heal slowly, the healing process being frequently interrupted by relapses.

The ulcerative process may involve both the upper lower and lateral segments of the cornea, but never passes beyond its centre.

Treatment.—The treatment of ulcers of the cornea is very similar to that of corneitis. In many cases, however, more especially those of marginal ulcer, the instillation of solutions of sulphate of eserine (gr. j. to iv. to ℥ j. of water), three times a day or oftener, will be found most beneficial. The yellow oxide of mercury ointment combined with atropine should be used in the small central ulcer of children as well as in phlyctenular or pustular ulcers. Slight cauterisation of the edges and surface of the ulcer with a point at dull red heat does much good in obstinate cases of sloughy or serpiginous ulceration or in those associated with hypopyon. In all severe cases the eye should be kept carefully bandaged. Iridectomy should be performed in any case should perforation be imminent. The operation reduces tension and gives time for the damaged tissue to recover itself. In no case of corneitis or corneal ulceration must the patient be confined to dark rooms or kept indoors.

Opacities of the cornea are the result of inflammation, ulceration, or injury.

They are met with of all densities and sizes; thin cloudy opacities are known as "nebulæ," dense white ones as "leucomata." A dense white opacity, involving the whole cornea, is called a "total leucoma;" an opacity of the same description occupying a part only, a "partial leucoma." Should a corneal opacity have been caused by a perforating ulcer or wound of the cornea, an "anterior synechia" will probably be found associated with it and is called an "adherent leucoma."

False pterigium.—*Fleshy opacities* are sometimes met with near the margin of the cornea, and continuous with the conjunctiva. They are composed of granulation tissue, and are frequently the result of burns.

Transverse calcareous bands are sometimes met with stretching across the centre of the cornea. They are probably of gouty origin; it is possible to scrape the calcareous matter away, but the opacity will probably re-form.

Treatment.—Corneal opacities have always a tendency to disappear, especially in children. Their removal may be aided by the use of slightly irritating applications, which set up a certain amount of increased vascularity, and thus aid absorption. The remedies generally employed are drops of sulphate of copper, (see p. 117); turpentine, pure, or mixed in various proportions with olive oil; calomel powder, or the yellow oxide of mercury ointment. Any of these may be used for some considerable time. Should no improvement have taken place at the end of twelve months, and the opacity be so situated as to interfere with vision, an artificial pupil must be made, and if the opacity is disfiguring it should be tinted (see Part II.). The fleshy opacities may be removed by operation, but are very liable to reappear in their former site.

Injuries.—Abrasions of the cornea may be caused by scratches from thorns, ends of straw, finger-nails,

etc. They give rise to severe pain, much intolerance of light, and watering of the eye.

Treatment.—The eye should be kept carefully bandaged with lint soaked in belladonna lotion till the abrasion has healed. Some solution of cocaine (gr. x. to ℥ j.) should be dropped in frequently if there is much pain.

Penetrating wounds of the cornea generally involve the iris or lens. They are liable to be followed by anterior synechia, iritis, or traumatic cataract.

Very extensive wounds of the cornea may allow the escape of the lens or vitreous.

Treatment.—When the iris is prolapsed it must be returned, and if possible retained in position. If it cannot be returned a careful iridectomy including the prolapse must be performed. In cases where the lens has been wounded or iritis set up, solution of sulphate of atropine—gr. $\frac{1}{2}$ to gr. j. to ℥ j. of water—should be dropped into the eye from three to six or eight times a day, and the eye should be carefully bandaged with lint soaked in belladonna lotion. (*See also* Injuries of Iris).

Should the lens swell and cause pain and increase of tension, it must be removed without delay, or iridectomy must be performed.

Iridectomy may have to be performed at some future time for optical reasons, or to obviate the irritation caused by dragging on an anterior synechia. Traumatic cataract may also require to be treated.

Burns of the cornea by lime, hot metals, etc., usually occur in conjunction with like injuries of the conjunctiva; they usually leave behind them opacities of greater or less extent and density, according to the severity of the injury, or may cause sloughing and destruction of the whole or greater part of the cornea.

Treatment, the same as that of burns of the conjunctiva.

The Episcleral Tissue.

Episcleritis is an inflammation of some of the tissues of the eyeball situated between the insertions of the lateral recti muscles and the cornea. Though its name implies inflammation of the episcleral tissue alone, the adjacent sclerotic as well as the conjunctiva are usually affected. The disease is not common; it is characterised by the presence of a rather dusky-red swollen patch covered by engorged conjunctival vessels and situated about the insertion of an internal or external rectus muscle.

The patches often disappear from one portion of the globe, and appear again at another; the inflammation is chronic in its course, but subsides after a time, leaving some discoloration of the affected part; it is very liable to recur.

It occasionally follows operations for strabismus.

Treatment.—Sedative applications, as decoction of poppy-heads or belladonna fomentation should be used three or four times a day, and if there is much conjunctival vascularity or any mucous discharge, some astringent, as boracic acid lotion (see Formulæ, p. 117) should also be employed.

Any constitutional treatment that may appear called for should be adopted. In some cases tonics do most good; others again are greatly benefited by a course of mercury or iodide of potassium.

The Sclerotic.

Staphyloma.—A bulge of the sclerotic may occur from softening of its structure by inflammatory changes, which usually commence in the choroid.

Stapyloma may be met with in the ciliary region (ciliary staphyloma), about the equator (equatorial staphyloma), or near the optic nerve (posterior staphyloma). Little can be done in the way of treatment.

Gummata are occasionally seen upon the sclerotic; they occur as vascular, well-defined bosses, either singly or in groups of two or three. Their diagnosis is not easy; they are likely to be confounded with sarcoma or patches of episcleritis. From the former they can be distinguished by their course, which is, though slowly, towards recovery, from the latter by being more abruptly defined and raised above the surface of the globe.

They are generally associated with syphilitic history, and often with other manifestations of syphilis. They require vigorous antisyphilitic treatment.

Sclero-keratitis is an extremely chronic relapsing form of inflammation of the ciliary portion of the sclerotic and episcleral tissue, and adjacent cornea. It is characterised by deep violet, patchy congestion and swelling of the ciliary region, and irregular patchy opacity of the corresponding portions of cornea. As the disease progresses, iritis is set up. There is often much pain and intolerance of light. In some cases the tension of the globe is increased. After some weeks or months the inflammation subsides, but sooner or later relapses; eventually—perhaps after a year or more—recovery takes place, but the cornea is left more or less opaque and the sclerotic stained and bulged in places. The disease occurs in young adults, most frequently women. The patients are generally unhealthy delicate people; they may be strumous or syphilitic, and have often a gouty family history.

Treatment.—Locally, nothing does so much good as the instillation of eserine drops, but if iritis exist atropine

must be substituted. Sedative fomentations or the application of dry heat, with leeches to the temples should be employed to relieve pain. The eye should be protected from light by a shade, bandage or protectors. If the globe becomes hard and remain so in spite of the use of eserine, iridectomy should be performed.

Iodide of potassium with perchloride of mercury combined with tonics, or tonics alone should be administered according to circumstances.

Hydrophthalmos (buphthalmos, congenital glaucoma, keratoglobus) is a gradual enlargement of the cornea, anterior portion of the sclerotic and iris, with deepening of the anterior chamber, and increased tension of the eyeball. Cupping and atrophy of the optic nerve often occur, and spontaneous hæmorrhage into the anterior chamber or vitreous, followed by disorganization and subsequent shrinking of the globe may take place. The disease which is sometimes described as infantile or congenital glaucoma is present at birth or commences soon after. It is often if not always preceded by violent iritis. Operative treatment is not admissible; either sclerotomy or iridectomy being followed by intraocular hæmorrhage; eserine may do good.

Injuries.—The sclerotic may be wounded by sharp instruments, or ruptured by blows; in the latter case the lesion usually takes place in the ciliary region, near the upper margin of the cornea.

The sclerotic (as also the cornea) may be pierced by a shot, chip of metal, or other small foreign body, which may be lodged within the globe or have passed clean through it.

Treatment.—The treatment of injuries of the sclerotic depends much upon the extent and nature of the damage done.

Small incised wounds will usually heal readily enough

if the eye is kept carefully bandaged. I arger wounds require to be closed by a suture which need only be passed through the conjunctiva.

Blows often cause complete disorganization of the globe, the aqueous and vitreous chambers being filled with blood, and hæmorrhage having taken place between the sclerotic and choroid, although no rupture of the external tunic has occurred.

Such cases must be carefully watched, and the eye kept bandaged with lint soaked in belladonna lotion. If the eye becomes painful or begins to shrink it must be excised.

In cases of extensive incised wounds, large ruptures, or wounds associated with lodgment of a foreign body within the globe, extirpation of the eyeball will probably have to be performed.

The Crystalline Lens.

Congenital anomalies.—Variations in shape, absence of the whole (aphakia) or part of the lens, and displacements, are met with as congenital defects.

Injuries.—Opacity of the lens (traumatic cataract) may be caused either by penetrating wounds of the cornea or simply by concussion.

Dislocation of the lens.—As the result of blows upon the eyeball, the lens may become partially or entirely displaced; it may still retain its transparency, but often becomes more or less opaque.

Displacement of the lens may take place upwards, downwards, or laterally; forwards into the anterior chamber, backwards into the vitreous, or it may be entirely extruded from the globe through a wound in the sclerotic, and be absent entirely or lie beneath the con-

junctiva. In the three first positions the displacement is only partial and the margin of the lens can be seen by oblique illumination occupying some part of the pupil.

In displacement forwards the pupil will be found dilated, irregular in shape, and fixed; oblique illumination will show the lens lying partially or entirely in the anterior chamber.

In displacement backwards the iris will be tremulous, the pupil sluggish, and the anterior chamber deepened. Direct ophthalmoscopic examination will probably detect the lens lying in the ciliary region at the lower part of the eye.

In displacement beneath the conjunctiva the lens is found forming a small rounded tumour somewhere near the corneal margin most frequently at its upper part.

Treatment.—If the lens is displaced partially, or into the anterior chamber and still retains its transparency it may be left alone. But should it become opaque it must be removed by extraction, or an artificial pupil may be made in such a position as to allow of light entering the eye by the side of the opaque lens. If the lens sets up irritation it must be extracted with a scoop, or sharp hook, iridectomy being performed at the same time, if it has not already been done (*see* Extraction, Part II., Chap. V.) some vitreous will probably be lost during the operation.

A transparent lens may remain for years in the anterior chamber, and, with the exception of impairment of vision, give rise to no inconvenience. If its capsule has been ruptured, however, it will become opaque and if not extracted will be removed by absorption. A lens displaced into the vitreous chamber will very probably act as a foreign body, and set up glaucomatous changes

in which case it should be removed at all risks; but if it causes no irritation it is best left alone.

A lens displaced beneath the conjunctiva may be left alone or removed at discretion.

Cataract will be considered in the section on operations.

CHAPTER VIII.

The Iris and Choroid.

Congenital Anomalies.

Coloboma.—A cleft condition of the iris or choroid, dependent on failure of closure of the fœtal fissure is known as "coloboma." In the iris it occurs as a deficiency of the lower segment, appearing as if iridectomy had been performed downwards; in some rare cases the cleft is above. In the choroid it is seen (on examination with the ophthalmoscope) as a brilliant white figure, commencing at the optic disc, and continuing downwards and forwards for a variable distance towards the ciliary processes, through which, in extreme cases, the cleft extends and is even continuous with a similar deficiency of the iris.

Central deficiency.—In some cases a central nearly circular hole is met with in the choroid as a congenital defect.

In the **albino** the pigment of the iris and choroid is absent to a greater or less extent, and with the ophthalmoscope the fundus of the eye appears of a yellowish-white colour, and traversed by innumerable blood-vessels.

Irideremia, or congenital absence of the iris, is occasionally observed.

Persistency of the pupillary membrane.—Small portions of the membrane, which at a period of fœtal life covered the pupil, occasionally remain, and are seen as one or more fine threads, somewhat resembling cobwebs, passing across the pupillary area, and attached at either end to the anterior surface of the iris, near the margin of the pupil. The thread is often double at one end and single at the other.

Anomalies of colour.—The irides in the two eyes may be different colours; thus the colour in one eye may be brown, whilst that of its fellow is blue, or differences in colour may occur in different parts of the same iris.

Tremulous Iris, Tumours.

Tremulous iris (iridodonesis) signifies a tremulous condition of the iris, which shakes about as the eye is moved. This condition is met with when the iris has lost the support of the crystalline lens, when the vitreous humour is abnormally fluid, or the iris totally paralysed.

Tumours seldom originate in the iris itself, but its structure often becomes implicated by growths commencing in deeper parts of the globe (*see* Tumours of Eyeball). Instances, however, of malignant growths, dermoid and simple cysts, and of the cysticercus, have been met with in the iris.

Inflammation of the Iris (Iritis).

Causes.—The causes of iritis are local and constitutional, most cases, however, are of the latter origin.

Local.—Irritation from foreign bodies in the conjunctival sac or cornea; friction of the cornea by granular lids or inverted lashes; injuries to the iris itself by operations, or accidents, with or without the lodgment of foreign bodies in its substance or on its surface; pressure by a swollen crystalline lens, exposure from perforation of the cornea, and exposure to cold, especially draughts.

Constitutional.—Debility after acute disease, overlactation, etc.; certain specific diseases, as syphilis, rheumatism and gout.

Symptoms.—The following symptoms are met with in most cases of iritis: changes of colour, cloudiness and

loss of polish of the iris, sluggishness or complete immobility and (as a rule) contraction of the pupil, injection of the ciliary region (ciliary redness), watering of the eye, and impairment of vision. Other symptoms met with occasionally are pain, intolerance of light, irregularity in outline of the pupil, inflammatory products—pus or lymph nodules—visible to the naked eye.

Three varieties of iritis are commonly met with. 1. Simple iritis. 2. Recurrent or rheumatic iritis. 3. Syphilitic iritis.

Simple iritis.—All the more constant symptoms of iritis are present, often accompanied by more or less severe pain. An uncomplicated attack lasts from one to two weeks or longer, and usually ends in resolution, the iris quite recovering its normal condition, but a few adhesions may form between the iris and lens-capsule (posterior synechiæ). In this as well as in the other forms of iritis, however, the inflammation may run on to the formation of a considerable quantity of new material or into suppuration. When suppuration takes place, the iritis is sometimes described as a separate variety "suppurative iritis." Iritis accompanied by the production of clear fluid causing the anterior chamber to appear unusually deep is described as "serous iritis." Serous iritis is sometimes met with after operations for cataract and may be a source of considerable danger to the eye. It is generally accompanied by slight—at times by great—increase of tension of the globe.

Recurrent or rheumatic iritis occurs in persons who are subject to attacks of rheumatism, (more especially gonorrhœal rheumatism), or gout, and also in the children of rheumatic or gouty parents; an attack of this form of inflammation presents all the more constant symptoms of iritis, and has one character peculiar to itself, *viz.*, its tendency to recur, some patients having

had as many as twenty or more separate attacks; in some cases the attacks observe a remarkable periodicity, recurring regularly at the same time of year. The inflammation sometimes appears in one eye, sometimes in the other, or perhaps in both, rarely however, simultaneously, but at short intervals, the second eye becoming affected long before the first has begun to recover. Recurrent iritis is frequently accompanied by more or less haziness of the cornea and aqueous humour. In some cases very severe pain of a dull aching character is experienced in the eyeball, forehead, side of nose, and temple; in others the attack is most insidious, the patient's attention not being attracted until a considerable amount of new material has been thrown out, extensive adhesions formed, the sight of one eye much impaired and the inflammatory action extended to the other. The great feature of this form of iritis is its tendency to recur. The cause of the recurrences is not very evident; they are probably due primarily to "posterior synechiæ," and may be prevented by the performance of iridectomy.

All persons, however, who have "posterior synechiæ" are not subject to recurrent iritis; so that in all probability in those who are liable to repeated attacks there is some constitutional vice which renders their irides liable to inflame upon slight provocation, such as the dragging on posterior synechiæ.

Syphilitic iritis is, perhaps, the most common of all the forms.

A typical case presents all the constant symptoms of iritis in a very marked degree, the zone of ciliary redness being extremely well-defined. There may be, besides, certain peculiar nodular excrescences, of a dirty yellow colour (known as lymph-nodules), situated on the surface of the iris or at its pupillary margin, and

at times extending into the pupil, which may be completely blocked by them. These excrescences are syphilitic gummata, and their existence renders the diagnosis of syphilitic iritis certain; they are, however, only occasionally present, and in the greater number of cases met with, the surgeon will have to take into consideration the patient's previous history, ascertain the existence of other signs of syphilis, and make his diagnosis accordingly.

Syphilitic iritis occurs most frequently between the ages of fifteen and forty, but is occasionally met with as a manifestation of congenital syphilis in infants, and often in cases of interstitial keratitis.

Results of iritis.—In many cases, especially if early and properly treated, perfect recovery takes place; in others permanent signs of inflammation are left. The morbid changes more commonly met with are:—

(1) The iris itself may be found swollen so as nearly to fill up the anterior chamber; atrophied, rigid, or rotten, and very prone to bleed freely on the slightest wound. These latter conditions become most apparent when operating upon its structure. On attempting to perform iridectomy, considerable difficulty will be experienced in removing a portion of the iris, which may be so tough that none of it can be torn away, or so rotten that only the portion included between the branches of the forceps is removed; or hæmorrhage may take place to such an extent as to prevent the completion of the operation.

(2) **Adhesions to neighbouring parts (synechiæ)** may have formed; those most commonly met with being between the iris and lens-capsule (posterior synechiæ.)

Posterior synechiæ are generally situated at the pupillary margin, and vary in extent from a few adherent tags of this part only, to complete adhesion of

the whole posterior surface of the iris to the lens-capsule, this latter condition being known as "total posterior synechia." When the pupillary margin is entirely bound down to the lens-capsule, and no communication exists between the two divisions of the anterior chamber, and the surface of the iris becomes bulged forward between the pupil and its greater circumference the pupil is said to be "excluded."

Adhesion of the iris to the cornea (anterior synechia)—should this occur at all as the result of iritis—will be found about its greater circumference.

(3) **Blocking of the pupil** by inflammatory material (occlusion); *opacities upon the lens-capsule* caused by adhesion of "uvea" detached from the posterior surface of the iris.

(4) **Capsular cataract.**—Dense inflammatory deposits in or beneath the lens capsule, or involving the superficial fibres of the lens itself (capsular cataract), may also be met with.

Treatment.—In treating iritis we must take care, *firstly*, to remove any local cause, such as a foreign body, opaque swollen lens, etc., and to cure granular lids, or remove inverted lashes. *Secondly*, we must endeavour to dilate the pupil. *Thirdly*, to relieve pain. *Fourthly*, to employ any constitutional treatment that may appear called for. (The means of carrying out the first indication are detailed elsewhere).

In order to dilate the pupil, a few drops of a strong solution (gr. iv. to ℥ j.) of sulphate of atropine should be placed between the eyelids by the surgeon himself at each visit, and a weaker solution (gr. $\frac{1}{4}$ to gr. i. to ℥ j.) should be used by the patient from four to eight or twelve times a day. If the case is treated at the commencement, more or less dilatation of the pupil will usually take place; but should the iris have become

infiltrated with inflammatory matter, and adhesions formed, little or no effect will be produced; the atropine should, however, be persevered with.

Atropism.—Some patients are extremely intolerant of atropine; in such it produces swelling and inflammation of the eyelids and face of an erysipelatous appearance, known as "atropism".

If atropism occurs a substitute must be found for the atropine. Daturine, hyoscyamine, duboisine,[*] homatropine,[†] or other mydriatics, in solutions of gr. i. to iv. to ℥j., may be tried, or the atropine may be used in the form of an ointment, gr. $\frac{1}{4}$ of sulphate of atropine to ʒj. of vaseline. In one case I found, after all else had failed, that mixing gr. i. of carbolic acid in ℥j. of atropine solution prevented atropism. Boracic acid may also be used.

In cases of iritis with suppuration, the eye should be fomented frequently with hot belladonna lotion, and kept bound up with lint soaked in the lotion.

In cases accompanied by much pain blood should be taken from the temples by leeches or the artificial leech. Atropine may give rise to pain by causing dragging upon adhesions, and should be used with caution in cases where its application is attended by much suffering, especially if it has no effect on the pupil. The eyes should be protected from light by a green shade or protectors until the inflammation has subsided. The hot coil is often of great use, both in suppurative and painful iritis. In serous iritis with increased tension eserine (grs. ii. to iv. of sulphate to ℥j. of water) should be used instead of atropine. The tension will

* Duboisine must be used with caution as poisonous effects have followed its application in even weak solutions.

† The sulphates of daturine, hyoscyamine, and duboisine, and the hydrobromate of homatropine are the salts most frequently used.

be still further increased by atropine and will do more harm to the eye than is likely to occur from posterior synechiæ however extensive. Eserine has a marked effect in lowering tension as well as contracting the pupil (*see* Glaucoma).

Of *constitutional remedies* there is none so useful in the treatment of iritis as *mercury*. The drug should be given in some form or other, so as to speedily affect the system, in all cases where inflammatory products are plentifully produced, whether the inflammation be of syphilitic origin or not. A pill containing gr. ij. of pil. hydrarg. and gr. ¼ of pulv. opii may be taken three times a day, and is a very convenient and effectual mode of administration. Mercurial inunction, or vapour baths, or hypodermic injection of perchloride of mercury, may be employed if preferred.

If the iritis occurs in debilitated states of the system, or the inflammation goes on to suppuration, tonics, as iron or quinine, should be prescribed, and a plentiful supply of good food given. Should there be much pain opium must be given, and it is well to prescribe the drug in conjunction with extract of belladonna or hyoscyamus. In rheumatic iritis, salicylate of soda, in doses of gr. xv. to xxx. combined with gr. ij. of quinine, three times a day, often does much good. In gouty cases colchicum and alkalies should be given.

The results of iritis, should they seriously interfere with vision, require the performance of iridectomy or some one of the operations for artificial pupil. Iridectomy should also be performed in cases of recurrent iritis. The removal of a portion of iris in some manner—probably by preventing dragging on adhesions—has an effect in preventing recurrence.

Injuries.—The iris may be cut, torn, or bruised; prolapsed through, or adherent to, the cornea, in cases

of penetrating wounds of that structure (*see* Wounds of the Cornea); or it may be separated from its insertion to a greater or less extent by concussion, without external wound. Any of these injuries are liable to set up iritis, which may possibly be followed by suppuration.

Treatment.—In all recent cases of injury where the iris has become prolapsed, or is adherent to a wound in the cornea, an attempt must be made with a curette or small spatula, to return it to its proper position. Then, if the wound is near the centre of the cornea, atropine should be freely used and the eye bandaged with lint soaked in belladonna lotion. But if the wound is near the corneal margin, eserine should be employed, and the eye bandaged with wet lint. The object in each case is to draw the iris as much away from the wound as possible; in the first by dilating, in the second by contracting the pupil. In the case of a wound near the corneal margin, eserine should be discontinued as soon as the wound has healed and atropine substituted, so as to dilate the pupil and prevent the occurrence of synechia, should iritis supervene. It is worse than useless to attempt to return prolapsed iris more than thirty-six hours after an injury, as it will be found firmly adherent to the edges of the wound. In extensive wounds also, as when the cornea is cut clean across or starred, it is of little use to attempt to return the iris, as it will again prolapse as quickly as replaced. In such cases and where from any cause the prolapsed iris cannot be returned, iridectomy including the prolapse should be performed. In injuries not associated with corneal wound and prolapse, or adhesion, the injured eye should be kept carefully bandaged with lint soaked in belladonna lotion, and if much pain is complained of, or inflammatory symptoms arise, blood should be freely taken from the corresponding temple, either by

leeches or the artificial leech, and hot fomentations or the hot coil applied.

As in iritis from other causes, the pupil may become blocked, or extensive synechiæ form, requiring operative interference at some later period (*see* Operations on Iris).

Diseases of Choroid.

Hyperæmia.—Increased vascularity of the choroid is not unfrequently met with, more especially in myopic persons; it should be suspected if a feeling of fulness and tension of the eyes, accompanied by watering and intolerance of light, is complained of.

On examination with the ophthalmoscope increased redness of the choroid (especially of that portion nearest the outer side of the optic disc) and some enlargement of the choroidal vessels can be made out; these changes will, however, very probably be overlooked by an inexperienced observer.

Treatment.—The eyes should be kept carefully at rest, protected from light, cold douches employed, and all positions (as stooping or hanging the head) which cause congestion of the eyeballs carefully avoided; blood may be taken from the temples, and if glasses have been worn their use must be discontinued. When the more acute symptoms have passed off any anomaly of refraction must be carefully neutralised by suitable lenses.

Inflammation of the choroid "choroiditis" and its sequel, choroidal atrophy, are most commonly caused by syphilis either congenital or acquired. A chronic form of choroiditis affecting the whole of the choroid, or only its central part, "central choroiditis," is met with in persons past the middle of life; choroiditis also occurs in myopia

of high degree, associated with iritis as "choroido-iritis," and the choroid is intensely inflamed in sympathetic ophthalmia.

Symptoms.—Excepting in the cases of choroido-iritis and sympathetic ophthalmia, the diagnosis of choroiditis can only be made by ophthalmoscopic examination. Pain, intolerance of light, impairment of vision, fulness of veins emerging from the sclerotic in the ciliary region, ciliary redness, dilatation and sluggishness of the pupil, and increased tension of the globe are symptoms often met with in choroiditis, but are by no means constant or characteristic.

The changes seen with the ophthalmoscope are, in the early stage, greyish or yellowish spots or patches of exudation surrounded by more or less redness. If the disease has lasted any length of time atrophic areas will be found mixed up with the exudation. The exudation may occur in one or more large patches, or be distributed over the choroid in the form of spots "choroiditis disseminata." We know that the morbid changes seen, are in the choroid, if the retinal vessels pass in front, without being obscured by them.

The retina is, however, frequently involved in the inflammatory process, in which case the vessels may be obscured, and it is difficult to tell where the inflammation has commenced, and which structure is most affected. Experience, however, teaches that large yellowish or greyish ill-defined opaque patches, or dirty yellow scattered spots, belong to the choroid; whilst in inflammation of the retina the opacity is more milky or opalescent if in patches; glistening and bright if in spots.

The optic disc is often affected if choroiditis exists in its vicinity. It becomes somewhat swollen, and looks dirty and opaque; the retinal vessels become thinner than normal, and the disc may pass into atrophy. In

some cases where the ocular tension is increased the disc becomes cupped and eventually atrophied.

A typical case of syphilitic choroiditis is characterised by the presence in the choroid of yellowish nodules similar to those seen in syphilitic iritis; but as in the latter disease, typical cases are only occasionally met with, and we must be guided by the same rules in making a diagnosis. The ophthalmoscopic appearances in choroiditis caused by congenital and acquired syphilis are similar.

Choroiditis disseminata is syphilitic; the atrophic changes left by it are seen as white or dirty white spots, showing holes in the choroid, through which the sclerotic is seen more or less distinctly, and dark spots consisting of accumulation of pigment. An irregular pigment-bounded ring of atrophy extending round the discoloured optic disc is met with in some cases of old syphilitic choroiditis.

Opacity in the vitreous occurs in choroiditis, more frequently in the syphilitic form. Displacement of the retina may take place from effusion between it and the choroid. Opacity of the lens commencing at its posterior pole "posterior polar cataract" may occur, and gradually extend over the posterior surface of the lens finally involving the whole of it and forming a variety of soft or cortical cataract. Cataract occurring in early adult life is commonly of this nature.

The chronic form of choroiditis, or as we generally see it, of atrophy of the choroid attacking the eyes of persons past the middle of life comes on without apparent cause. The ophthalmoscope in some cases shows a peculiar mottled or marbled appearance of the fundus, an exaggeration of the condition mentioned at p. 40 as occurring in normal eyes; it is caused by abnormal distinctness of the choroidal vessels due to

wasting of the pigment. In some instances instead of the mottling, a striped appearance is produced, and in other cases the pigment appears to be entirely worn away over areas of varying extent and the sclerotic shows plainly through.

In "central choroiditis" a hæmorrhage is probably the cause, and at first we may make out the effused blood, often, however, more or less shrouded by inflammatory exudation. As time goes on the blood and inflammatory products become absorbed and a more or less circular patch of atrophy remains occupying the centre of the fundus. Choroiditis almost always attacks both eyes; not always in the same degree, the disease being often far advanced in one eye when just commencing in the other. Its effect on vision depends on the amount and part of choroid affected; considerable change may take place in the peripheral parts, without much affection of vision, but a very small patch of exudation in the region of the yellow spot, as in central choroiditis, causes great impairment. In some cases, however, remarkably good vision may be preserved, though the choroid appears to be riddled with holes (atrophy), and presents more or less marked signs of recent inflammation; and in such the amount of vision depends upon the extent to which the retina is involved in the inflammatory or atrophic process.

For changes in the choroid in myopia see pp. 69—72.

Treatment.—The treatment of choroiditis should be very similar to that of iritis; in chronic cases a long course of perchloride of mercury does good. Iridectomy does good in some chronic cases or in those in which there is increase of tension of the globe. For the atrophic changes no treatment is of much avail.

Injuries.—The choroid may be injured by foreign bodies entering the eyeball, or ruptured by violence, without perforation of the tunics.

In the former case (more especially if a foreign body is lodged in the structure of the choroid) inflammation is very liable to follow, the eyeball being eventually lost by suppuration or shrinking. A rupture of the choroid from external violence is generally situated near the margin of the optic disc, is attended with more or less hæmorrhage, which fills the rent with blood, and may cause considerable displacement of the retina.

Seen with the ophthalmoscope soon after the receipt of the injury, a rupture of the choroid appears as a more or less elongated blood-clot; later the blood becomes absorbed and a white linear or curved figure is left, from the white sclerotic showing through the rent in the choroid. This form of injury is not often followed by destructive inflammation. The damage to sight depends upon the size and position of the rupture, and whether displacement of the retina is caused or not.

Treatment.—A simple rupture of the choroid should be treated by giving rest to the eye by bandaging and the instillation of atropine; and by blistering behind the ear or on the temple. In injuries associated with wound of the sclerotic, cornea, or iris, the treatment recommended for injuries of these structures should be adopted.

Cyclitis.—Inflammation of the ciliary portion of the choroid (ciliary body), in typical cases, is characterised by dusky red swelling of portions or the whole of the ciliary region, engorgment of the retinal veins, and probably of those of the choroid and iris, pain in the eyeball aggravated by pressure in the ciliary region, some inflammatory opacity in the vitreous and probably slight increase of tension of the eyeball, and there may be keratitis punctata. It is very frequently associated with slight or even severe iritis (irido-cyclitis).

Cyclitis may be caused by injury, or may depend on syphilis inherited or acquired. In the former case the

inflammation is often of a plastic nature. In many cases, more especially those of syphilitic origin, complete recovery takes place, more or less dark staining of the ciliary region being left. In some cases, more especially those associated with iritis, great increase of tension occurs "secondary glaucoma" being set up. In other cases softening and shrinking of the globe follows; suppuration may also take place.

Wounds of the ciliary region should always be looked upon as much more serious than those of other parts of the eyeball, from their tendency to set up plastic cyclitis, ultimately destroy the eye, and place its fellow in danger from sympathetic ophthalmia.

Treatment.—Instillation of eserine (gr. ii. to ℥j.) or if there be iritis, without increased tension, of atropine. If increased tension exists, eserine must be used even though there be severe iritis. If the tension persists in spite of eserine, iridectomy should be performed. Iodide of potassium and perchloride of mercury should be given internally if the case is syphilitic, or indeed in any case arising spontaneously.

In traumatic cases no constitutional treatment is required, but the same local treatment should be adopted and the eye kept carefully covered with a black bandage placed over a pad of lint so as to exclude all light. If there is much pain the same treatment should be adopted as in painful iritis or corneitis.

Bone upon the choroid.—Deposits of bone are not unfrequently met with upon the inner surface of the choroid in eyes that have been blind and shrunken for years.

Tubercle in the choroid.—In cases of general tuberculosis deposits of tubercle have occasionally been met with in the choroid, and seen by the ophthalmoscope, appear as small white dots scattered about the fundus.

CHAPTER IX.

Sympathetic Ophthalmia—Sympathetic Irritation—Sympathetic Amblyopia—Vitreous Humour.

Sympathetic ophthalmia is the name applied to a peculiar form of inflammation of all the ocular structures but more especially of the choroid, ciliary body, and iris, coming on in the second eye in consequence of morbid changes which have previously existed or are still in operation in the one.

The most common causes of sympathetic ophthalmia are injuries of one eye, *especially wounds implicating the ciliary region*, or associated with *lodgment* of a foreign body in the interior of the globe. In such cases the wounded eye instead of recovering within a few weeks of the receipt of an injury, may become affected by keratitis punctata and choroido-iritis of a markedly adhesive character; pain more or less severe is complained of, and there is some intolerance of light; sight is rapidly reduced to perception of light, extensive synechiæ form, and the tension of the globe may increase. If we examine with the ophthalmoscope before the media have become too opaque we shall find opacity in the vitreous and optic neuritis, with perhaps retinal hæmorrhage.

The disease may stop here, the eye being left with the iris more or less altered in structure, and numerous posterior synechiæ formed; or with the pupil blocked by inflammatory exudation, its margin being entirely adherent round the whole of its circumference (occluded and excluded), whilst the remainder of the swollen vas-

cular iris bulges forward to the posterior surface of the cornea almost obliterating the anterior chamber, or the whole posterior surface of the iris may be adherent to the lens capsule, and the lens itself become opaque. If the inflammation continues the tension of the eyeball gradually diminishes and the globe shrinks. The whole process occupies many months and the course of the inflammation is often interrupted by remissions, during which we may have some hope that recovery will take place; to be again followed by fresh outbreaks. At any time during the foregoing changes in the injured eye, even in their earliest stage, a slight blush of the sclerotic of the sound one may make its appearance, and it may become irritable and painful, and a similar inflammation set up in it leading to like results. In some cases, however, the inflammation is of a milder type and confined to the iris (sympathetic iritis), and the eye may recover with only a few posterior synechiæ. As a rule sympathetic ophthalmia need not be feared till a fortnight or three weeks after the injury, but in some rare cases it has commenced as early as six days.

Treatment.—Where sympathetic ophthalmia has been once established, in all probability irreparable damage will be done; the great point to bear in mind is to prevent its occurrence by *timely extirpation of the damaged globe* (*see* Extirpation of the Eyeball). If the disease has become fairly established, little benefit can be expected to result from such extirpation, as the morbid changes will probably continue in the sympathetically inflamed globe, in spite of the removal of that primarily affected; the operation should, however, be performed if the inflammation has only just commenced.

The sympathetically affected eyeball, or, if excision has not been performed, both eyes should be kept carefully bandaged with lint soaked in belladonna lotion

and atropine freely used; all light must be carefully excluded by using a black bandage and keeping the patient in a darkened room. Pain must be relieved by the same methods as in cases of iritis. Any constitutional treatment that may appear necessary should be employed, and when the inflammatory symptoms have *entirely* subsided iridectomy should be performed. This operation often exerts a very beneficial influence upon the nutrition of the globe as well as making a way for rays of light to reach the retina (*see* Iridectomy), and should be repeated a second or even a third time should the new pupil become (as is very likely to be the case) occluded by inflammatory exudations; the great point to bear in mind is never to be in a hurry to operate, at least twelve months should be allowed to elapse after the last signs of inflammation have disappeared.

Should suppurative inflammation be set up in one eye, sympathetic changes need not be feared in the other; it is only in the adhesive form of choroido-iritis that sympathetic ophthalmia is likely to occur.

Sympathetic Irritation and Sympathetic Amblyopia.

Sympathetic irritation.—It not unfrequently happens that soon after the receipt of an injury to one eye its fellow becomes slightly painful, intolerant of light and irritable. These conditions may remain unchanged week after week and eventually subside. They make up what is known as sympathetic irritation.

When sympathetic irritation occurs we must always watch the injured eye carefully, and if signs of choroido-iritis or keratitis punctata appear, it should be immediately excised. If no such symptoms occur, however, its removal is not necessary.

Sympathetic amblyopia.—It sometimes happens that when one eye has been lost from injury or disease and is constantly inflamed and painful, the sight of the other becomes much impaired without any visible change taking place in its structure. This condition is known as "sympathetic amblyopia," and is generally cured by removing the blind and painful eye.

Diseases of the Vitreous Humour.

The vitreous can be thoroughly examined by direct ophthalmoscopic examination.

Disease of the vitreous is often associated with disease of the retina or choroid.

It may be the seat of acute or chronic inflammation, its consistence may be altered so that it becomes more fluid than normal, and it may shrink in bulk in which case it will probably drag away the retina from its attachments. The changes which can be seen in the vitreous whilst the eye remains in the orbit, are loss of transparency caused by opacities of various size and shape, moving freely or slowly, or in rare instances fixed. An idea may be formed of the consistence of the vitreous by noticing the rapidity of the movement of any particles seen floating in it; if their movements are rapid the vitreous is too fluid, but if they move sluggishly it is of normal consistence.

Acute inflammation of the vitreous alone sometimes occurs, it is probably syphilitic. The ophthalmoscope shows diffuse haze of the vitreous, vigorous antisyphilitic treatment will effect a cure.

Chronic inflammation.—Much more common is a chronic inflammation of the vitreous, secondary to

choroiditis, cyclitis or retinitis. The ophthalmoscope shows more or less diffuse haze, mingled with which, are large shreds or webs.

The treatment is as that of choroiditis, retinitis, (*see* Diseases of Choroid and Retina).

Opacities in the vitreous may be large dense masses, so large as barely to admit of any normal reflex from the fundus, muddy clouds stirred up from below on movement of the globe, membranes dense or gauzy; and beads, shreds, or threads, glistening scales, or numerous sandy dots, so numerous as to give the idea of general opalescence. Opacities in the vitreous are easily detected by direct ophthalmoscopic examination at a distance of 12″ to 18″, but if the eye is approached quite near they will not be seen so clearly as they lie too near the back of the lens. If the patient is directed to move his eye up and down quickly two or three times and then look straight in front of him, the opacities will be seen to pass across the illuminated fundus as dark figures on a red ground, showing that their movements are independent of those of the eyeball which is not the case with opacities situated in the cornea, lens or retina. In some cases only one or two small opacities exist and are found with difficulty and then lost again. Opacities near the outer surface of the vitreous are often attached to the retina or optic disc —more commonly the latter—they appear ill-defined and hazy and have no movement; they are single and are often first detected by indirect ophthalmoscopic examination as a circumscribed haze covering some part of the optic disc or its neighbourhood. By careful direct examination from different distances aided if necessary by convex lenses behind the sight hole of the ophthalmoscope, such an opacity can be accurately defined.

In sympathetic ophthalmia, as already stated, opacity appears in the vitreous; it is inflammatory.

In some cases though no definite opacity can be made out by the most careful examination, a diffuse haziness of the vitreous occurs, which blurs the outlines of the disc and retinal vessels, or indeed obscures them entirely, though a bright red reflex is returned from the fundus. The same appearance may be caused by diffuse corneal or lenticular haze, but in either case oblique illumination will show its position, whilst, if the opacity is in the vitreous, this method of examination will give only negative results. Crystals of cholesterine sometimes form in the vitreous they are the glistening opacities already mentioned. They may be very numerous and when the eye is moved appear like a number of dancing golden spangles or minute stars; the appearance is called *sparkling synchysis*, and may occur in eyes the vision of which is quite normal. Opacities from blood or lymph close to the back of the lens may be seen in their natural colour by oblique illumination.

Disease of the vitreous occurs in the higher degrees of myopia; the humour becomes fluid and opacities form in it which may be the result of former hæmorrhage. A foreign body, small piece of iron for instance may sometimes lodge in the vitreous and be visible. Bleeding into the vitreous may be caused by severe blows on the eye; the hæmorrhage may be so abundant as to entirely darken the interior of the eye and if near the back of the lens may—as already stated—be seen by oblique illumination. If only in small quantity and situated deep in the eye it is seen with the ophthalmoscope as a dark ragged cloud stirring up from below when the eye is moved and settling slowly down again.

Penetrating wounds of the eyeball cause hæmorrhage into the vitreous which may be followed later on by the

formation of lymph or pus, giving a greenish yellow colour when the eye is examined by oblique illumination or by daylight. In some cases of pyæmia the vitreous becomes infiltrated with pus.

Spontaneous hæmorrhage.—Hæmorrhage into the vitreous may take place spontaneously, usually to only a small extent; the blood becomes absorbed to a greater or less extent in the course of time, but very commonly some permanent opacity remains. In some rare cases, however, repeated attacks of hæmorrhage take place so that after a time the chamber becomes filled with blood. This may occur in two classes of cases. 1. In women about the climacteric. 2. In young adult males subject to bleeding from the nose and constipation. The sight of one or both eyes may be entirely destroyed, secondary cataract may form, the tension of the globe diminish, detachment of the retina take place and even shrinking of the eyeball follow.

The treatment of hæmorrhage into the vitreous depends on its cause. If traumatic, the eye should be kept bandaged, the pupil dilated with atropine, the patient kept at rest, on low diet without stimulants, and absorption promoted by the use of frequent blisters to the temple or behind the ear.

In the idiopathic form, the eyes must be kept at rest, and guarded from bright light by protectors; the patient should go about quietly, avoid straining, attention should be paid to the general health, uterine trouble should be treated if it exists. In the case of hæmorrhage associated with obstinate constipation some means should be taken to ensure a pretty free daily action of the bowels, by no means an easy task.

Cysticercus is occasionally seen in the vitreous.

CHAPTER X.

GLAUCOMA.

By Glaucoma we understand "a series of morbid changes of the eyeball; the most prominent of which, and apparently the one which causes all the others, being an increase of tension of the globe," (Bader). The cause of the increase of tension is unknown, but it is supposed to result from undue accumulation of the intra-ocular fluids dependent on hypersecretion or deficient removal. Glaucoma is said to be *simple* when the increase of tension progresses slowly and continuously without inflammatory outbreaks. Acute or chronic when attended by attacks of inflammation.

Simple glaucoma presents no very marked symptoms its onset being most insidious. It is characterised by gradual decrease of acuteness of vision, with narrowing of the visual field, impairment of the power of accommodation, causing rather rapid increase of presbyopia, sluggishness in movements of the iris, some dilatation of the pupil, and some apparent haziness of the crystalline lens. Increase of tension is probably one of the earliest symptoms, but is very liable to be overlooked until the disease is far advanced and considerable hardness of the globe has taken place. With the ophthalmoscope spontaneous pulsation of the retinal arteries may be seen, or pulsation may be produced by very slight pressure upon the globe. The vessels, especially the veins, are thinner on the surface of the optic disc than in the surrounding retina, and the disc itself may be more or less cupped. The cup of glaucoma is characterised by a bluish or dusky appearance of the

greater portion of the disc; upon this portion the vessels appear very small and indistinct, or they may be quite invisible; the margin of the disc is white, and the large tortuous retinal vessels are seen curling up over its edge, and appearing on the surface of the retina at a point not continuous with their course upon the nerve surface. Cupping of the disc requires long continued pressure for its production; it does not occur in the early stage of any form of glaucoma and its presence shows that sight is greatly and permanently damaged if not entirely lost. Small hæmorrhages may also be met with upon the retina.

Absolute glaucoma.—Sooner or later, in any form of glaucoma, if relief is not given, the condition known as *absolute glaucoma* is established. The eyeball becomes stony hard, the pupil widely dilated and fixed, the cornea hazy and anæsthetic, the iris and aqueous humour discoloured, the anterior chamber shallow, and the lens more or less opaque. A few dilated vessels (perforating branches of the anterior ciliary), figs. 16 and 18, pp. 22, 23, are seen issuing from the globe in the ciliary region, the sclerotic may be somewhat bulged in places and bluish in colour, and the conjunctiva is extremely rotten, tearing on any attempt to seize it with forceps. On examination with the ophthalmoscope all appears dark behind the pupil, or a dull red reflection may be returned from the interior, but no details of the fundus can be made out. All perception of light is lost.

In some cases of acute glaucoma, and almost invariably in chronic glaucoma, the onset of the disease is preceded by premonitory symptoms.

These are, as in simple glaucoma, rapidly increasing presbyopia and slight increase of tension of the globe, sluggishness and dilatation of the pupil, some apparent haziness of the lens, and narrowing of the visual field.

Besides these we may find some congestion of the vessels referred to above emerging from the sclerotic in the ciliary region. There may be periodic attacks of dimness of vision, objects appearing as if veiled by a greyish or yellow mist (London fog); in the later stages we may have a halo around a flame, or the appearance of a rainbow, and at times attacks of pain in and about the eyeball.

Acute glaucoma usually commences suddenly with well-marked inflammatory symptoms. The patient will state that he was seized (frequently during the night) with sudden severe pain in the eye; the pain will be described as affecting, not only the eyeball, but the whole of the corresponding side of the head, and he will have found that the sight of the painful eye is much impaired or entirely lost. On examination the eyelids will be found slightly reddened and swollen, the conjunctiva somewhat chemosed, and its vessels, as well as those situated more deeply in the subconjunctival tissue, enlarged. There will be profuse lachrymation, and often much intolerance of light; the aqueous humour will very probably be somewhat turbid. The pupil will be moderately dilated, somewhat irregular and fixed, and the tension of the globe greatly increased.

On examination with the ophthalmoscope some of the appearances mentioned under simple glaucoma may be found, but the media will probably be so hazy as to obscure the parts behind, a dull-red reflection being all that can be made out.

The acute symptoms may pass off in the course of a few days or weeks, leaving the eye more or less permanently damaged. Similar attacks may recur, but more frequently the disease relapses into a chronic state.

Glaucoma fulminans.—A form of acute glaucoma rarely met with, characterised by the suddenness of its

onset and extreme violence of its symptoms is known as "glaucoma fulminans." The eye attacked may be entirely and irremediably blinded in the course of a few hours. The attack is often accompanied by severe headache and gastric disturbance; indeed, in some cases, so marked have been these symptoms, that the ocular condition has been overlooked and the patient treated for a bilious attack.

Chronic glaucoma, the form most commonly met with, is characterised by the occurrence of slight inflammatory attacks, associated with temporary increase of dimness of vision and more or less pain in and around the eyeball. On examination the field of vision will be found to be limited, the tension of the globe increased, and if the patient presents himself during an inflammatory attack, the conjunctiva and subconjunctival tissue will be found unduly vascular, the pupil somewhat dilated, the movements of the iris sluggish, and the cornea steamy.

The loss of vision, in cases of chronic glaucoma, is attended by somewhat peculiar symptoms. Patients complain that their sight is always somewhat misty, that there is an appearance of a bright halo around a candle or other flame, that they see colours resembling a rainbow, and often of great beauty; and occasionally flashes of light and fiery circles, these latter symptoms are, however, common to all forms of retinal irritation. Vision is always worst during the inflammatory attacks and recovers to a certain extent during the remission, never, however, returning to the same condition as before the attack.

The ophthalmoscope shows changes similar to those mentioned under simple glaucoma.

Glaucoma is essentially a disease of the latter half of life, occurring most frequently between the ages of forty

and sixty, but occasionally in young adults, or even in children. Glaucoma almost always affects both eyes, not, however, simultaneously, but at more or less considerable intervals. The tendency to glaucoma is no doubt increased by uncorrected anomalies of refraction; an attack is often brought on by fatigue, as in a woman worn out by long nursing and sleepless nights.

Diagnosis.—In order to diagnose glaucoma we must be well acquainted with the method of ascertaining the tension of the globe, and also with the use of the ophthalmoscope (*see* Examination of Eyeball, etc.).

We must also remember that the injurious effects of pressure are evidenced earliest in the peripheral portions of the retina, and should therefore very carefully examine the condition of the *visual field* in all suspected cases (*see* Examination of Field of Vision). Cases are frequently met with in which great contraction of the visual field has taken place, although central vision is still acute.

Another symptom which should lead us to suspect glaucoma is the *rapid increase of presbyopia*. Patients affected by the simple or chronic forms of the disease are constantly changing their glasses, as they find that those which at first appear to suit become useless in the course of a few months.

Apparent haziness of the crystalline lens is a symptom requiring special attention; otherwise the surgeon may fall into the fatal error of mistaking chronic or simple glaucoma for cataract, and allow the disease to continue until sight is irrevocably lost. In such cases ophthalmoscopic examination will show that there is little or no real opacity of the lens, and this, aided by a careful examination of the tension of the globe and the state of the visual field, will prevent so disastrous a mistake. This condition of the lens is more marked in dark eyes

than light, and especially in those which are highly myopic.

Besides the foregoing we not unfrequently meet with what is known as "secondary glaucoma," *i.e.*, glaucoma coming on in the course of some other disease, as corneitis, ulceration of cornea, iritis, choroiditis, etc. Glaucoma occurring in young persons is usually secondary. Glaucoma following injury is spoken of as "traumatic glaucoma." Glaucoma associated with large and numerous retinal hæmorrhages is described as "hæmorrhagic glaucoma;" it is one of the worst forms of the disease and the most rebellious to treatment.

Treatment.—Glaucoma can be remedied *by operation alone*, and it is our duty to explain to the patient the nature of his case and to urge upon him most strongly the *necessity* for operative interference.

Patients suffering from glaucoma often evince the greatest unwillingness to undergo an operation; this unwillingness is explained by the fact that during the *remissions* of the disease little or no inconvenience is experienced, and, moreover, even at the time that an attack of inflammation is present the sufferer will be encouraged by the hope that the symptoms will pass off (as they in all probability have done in previous attacks) leaving the eye but little damaged. Nevertheless we must always bear in mind *that an operation, to be successful, must be performed early*, and we must not be satisfied until we have convinced our patient of this. Most patients will readily submit to an operation when one eye has been lost and the disease has commenced in the other.

Several operations have been practised for the relief of glaucoma, but iridectomy and sclerotomy are those which give the best results. Iridectomy or sclerotomy, to be effectual, should be performed as early as possible.

In simple glaucoma operative interference is anything but satisfactory; the most favourable result is, that the disease may be stayed at the stage at which it has arrived, but no gain of sight is to be expected. We must also bear in mind the possibility of the eye going quite to the bad after an operation. On the whole an operation in simple glaucoma should not be rashly undertaken. The course of the disease is very slow, and if our patient is advanced in years we may well leave him alone, hoping that his sight may last as long as he does. If, however, he has a prospect of living for many years, we have no alternative but to advise him to take his chance of an operation, and having decided to perform one, to do it with as little delay as possible. The operative treatment of inflammatory, especially of acute, glaucoma is much more satisfactory; as a rule, however, no good is likely to result from an operation in cases where vision has been reduced to bare perception of light; but in glaucoma fulminans much improvement may take place even though all perception of light has been lost for some days.

In performing iridectomy for glaucoma we must take care to remove the iris well down to its insertion and to excise a good broad piece (*see* Iridectomy), merely cutting away a portion of the iris near the margin of the pupil does no good. The operation is easy enough in cases of acute glaucoma, but in those of old standing, where the structures are rotten or the pupils so widely dilated that the iris has become a thin rim at the periphery of the anterior chamber, it is anything but simple. In such cases sclerotomy is to be preferred to iridectomy.

In cases of glaucoma where for any reason an operation does not seem advisable we must do our best to give relief by medical treatment. The means which will be found most useful are the instillation of solutions

of sulphate of eserine (gr. ii. to iv. to water ℥ j.), application of sedative fomentations, administration ot opium, and the local abstraction of blood by leeches or the artificial leech, with perfect rest of the eyes.

Atropine *should not be used* in glaucoma, as it causes increase of tension of the eyeball. Its application is recommended in some works on ophthalmic subjects, but it does more harm than good; eserine, however, has a contrary effect and is often of great benefit.

CHAPTER XI.

The Retina and Optic Nerve.

Diseases of the retina and optic nerve can be diagnosed by the ophthalmoscope alone. Before the introduction of this instrument all cases of want of sight arising without cause apparent to the unaided eye were collected together under the names of "Amblyopia" and "Amaurosis." To the former were referred all cases where vision was much impaired, but not entirely lost; to the latter cases in which no perception of light remained. But now that the ophthalmoscope has come generally into use, making the interior of the eyeball as accessible to our sight as the exterior, we have come to refer "amblyopia" and "amaurosis" to their proper causes, and the terms have fallen into comparative disuse. For instance, if in a case of want of sight we find on ophthalmoscopic examination that there is haziness of the vitreous, inflammation of the retina, or choroid, etc., we do not say, as formerly, that the patient is amblyopic, but that he is suffering from disease of the vitreous, retinitis, choroiditis, etc. Again, in cases of total blindness the ophthalmoscope will detect atrophy of the optic nerve, and instead of saying that the patient is "amaurotic," we say that he is suffering from optic nerve atrophy. The terms "amblyopia" and "amaurosis" may, however, still be used in some cases to be presently described, where there is partial or complete loss of sight, with an apparently healthy condition of the ocular structures.

Hyperæmia of the retina occurs from over-strain of the eyes, in doing near work (especially in hypermetropic or astigmatic eyes), or from constantly looking at bright light; the disease is not uncommon amongst engine-drivers and others who work over a blazing fire.

Symptoms.—The symptoms are dimness of vision, and a feeling of fullness and discomfort about the eyes; in hypermetropic or astigmatic individuals there will be the usual complaints of pain in the eyes, headache and inability to read or work for any length of time. The ophthalmoscope shows redness of the optic disc, engorgement and twisting of the retinal vessels both arteries and veins, with increase in the visible number of each. This form of hyperæmia may be described as active, another form affecting only the veins, which are found enlarged tortuous and sometimes varicose, depending on interference with venous circulation being looked upon as passive hyperæmia.

Hyperæmia of the retina, especially the active form, is not easily recognised, as the limits between health and disease fade almost imperceptibly into each other, and considerable experience is required in order to judge with certainty where one ends and the other begins.

Treatment.—Active hyperæmia must be treated by insuring perfect rest to the eyes. To this end all near work must be prohibited, the accommodation must be paralysed by using a solution of sulphate of atropine, (gr. ii. to iv., to ℥j.) three times a day or oftener; the eyes must be shielded from light by protective spectacles or shades. Leeches or the artificial leech should be applied to the temples from time to time, and purgatives given if necessary.

After subsidence of the hyperæmia any anomaly of refraction must be carefully neutralised, the eyes being

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well under the influence of a mydriatic during the examination.

Passive hyperæmia is generally an indication of some more serious disease and requires no special treatment. (*See* ISCHŒMIA).

INFLAMMATION OF THE RETINA—RETINITIS.

Causes.—Retinitis most frequently depends on some constitutional condition, as albuminuria, diabetes, gout, or syphilis; it may also arise from embolism of the vessels of the retina, hæmorrhage into its substance, or from cerebral disease; from tumours or entozoa within the globe, exposure to sudden flashes of bright light, or wounds of the eyeball. It may also be secondary to choroiditis, iritis, or cyclitis, and is a part of sympathetic ophthalmia.

Symptoms.—Retinitis is characterised by hyperæmia of the retina, associated with more or less dense and extensive opacity of its structure, either diffuse or in spots or patches, and frequently with extravasations of blood in its substance.

Disturbance of vision may be a prominent symptom, or the patient may hardly be aware that anything is amiss with his eyes. The degree of impairment of vision depends upon the situation and extent of the inflamed portion of the retina; for instance, a small patch of inflammatory exudation in the region of the yellow spot will cause much loss of sight, whereas a considerable amount of opacity situated peripherally will give rise to scarcely any symptoms.

Pain, photophobia, coloured vision, and flashes of

light, are symptoms occasionally met with in inflammation of the retina.

Acute retinitis is rarely met with, and if it should occur would hardly be recognised, as the inflammatory exudation would be transparent, and, therefore, invisible; consequently, the only appearance revealed by the ophthalmoscope would be enlargement and tortuosity of the retinal vessels.

The forms of retinitis which give rise to striking ophthalmoscopic appearances are essentially of a chronic nature, and are frequently associated with inflammatory changes in the choroid and optic disc.

Retinitis may affect one or both eyes, those forms which are of constitutional origin usually affecting both, though not always in the same degree.

The ophthalmoscope shows — 1. Hæmorrhages of variable size. 2. Spots of pigment. 3. A more or less general turbidity of the retina, varying from a scarcely perceptible cloudiness, (giving the idea that the structure is opalescent and visible instead of entirely transparent) to an uniform greyish-white or mottled opacity, which covers the choroid like a veil; conceals the outline of the optic disc and in parts covers the gorged, dark coloured, and tortuous retinal veins, and the normal or nearly normal arteries. 4. A number of opaque glistening white spots either quite discrete or running together and forming patches, seen chiefly in the region of the yellow spot, around which the opacities are often arranged in a radiating manner. 5. A number of small irregular yellowish patches scattered about the central part of the retina, but without any particular relation to it.

Varieties of Retinitis.

Hæmorrhagic retinitis.—The optic nerve is reddened, somewhat swollen, its outline obliterated, its transparency so much affected that the course of the retinal vessels upon its surface and in its substance cannot be traced; the retinal veins are turgid and tortuous in their course, presenting alternately breaks and dark portions, according as they lie deeply in the engorged blood-stained retina or more superficially near its inner surface. The retinal arteries are nearly normal or too thin.

The principal characteristic of the disease is the occurrence of extensive hæmorrhage, most marked around the optic disc, and fading away gradually into the surrounding parts. The blood-extravasations have a peculiar striated appearance, and radiate, spoke-like, from the optic disc as a centre. In some cases the retina immediately surrounding the disc is uniformly infiltrated with blood, the bright-red colour thus produced gradually shading off externally into the spoke-like appearance above mentioned.

As time goes on the extravasated blood undergoes changes, becoming brown in colour, and is eventually partially or entirely absorbed. The disease is said to be of gouty origin; as a rule one eye only is affected.

Retinitis pigmentosa is a peculiar form of degeneration of the retina, met with most frequently in the offspring of blood relations; the sufferers are often deaf and dumb, and may be idiotic; several members of the same family are often affected.

The most marked symptoms of the disease are *night blindness and gradual narrowing of the visual field without*

glaucomatous symptoms. The ophthalmoscope reveals the most striking changes; the retina, more especially about its peripheral parts, is dotted more or less thickly with black pigment spots; these spots appear somewhat like a multitude of small black spiders with many legs; they have also been likened to bone-corpuscles. The spots of pigment appear to follow the course of the blood-vessels of the retina, and, as before stated, are collected most thickly in its peripheral parts.

The blood-vessels themselves are much diminished in size and visible number, and the optic disc is markedly anæmic, and of a peculiar waxy appearance; cataract not unfrequently occurs.

Albuminuric retinitis is a form of retinitis met with in Bright's disease. The changes which take place in the retina are inflammation with effusion and hæmorrhages, followed by fatty and fibrinous degeneration of its structure, and subsequent atrophy.

The ophthalmoscope shows, in the early stages of the disease, retinal hyperæmia (more especially venous) with increased vascularity and redness of the optic disc. Next the retina becomes cloudy (more especially around the optic disc, the outline of which becomes obscured), and hæmorrhages in the form of streaks and spots occur in various parts of its structure.

The cloudiness goes on increasing, and obscures the smaller vessels; later in different parts of the fundus, but mostly in a ring situated at a little distance from the margin of the disc, appear glistening white spots and patches; and still later the disc itself becomes grey and opaque.

Whilst the above changes are going on in other parts of the retina, characteristic appearances may be developed in the region of the yellow spot. A number of small white glistening spots, which do not at first

coalesce so as to form a patch but remain distinct, make their appearance. These glistening spots are arranged in a radiated position around the macula as a centre, and somewhat resemble a constellation; the appearance is quite characteristic, and once seen is not likely to be forgotten. As the disease advances the spots may run together into elongated patches.

As the opacity of the retina increases, the vessels become more and more obscured, so that when the disease has reached its height, only a few large venous trunks are still visible. Fresh hæmorrhages may occur at any time, and cover over and obscure the opaque portions of retina. After a time a retrograde process sets in, the hæmorrhages and peculiar opacity slowly disappear, the retina being at length left in a state of atrophy. Displacement of the retina may occur. In many cases the changes in the yellow spot region accompanied by a few small blood spots scattered about in other parts are the only appearances noticed, and little or no change takes place for months or even years.

Albuminuric retinitis is usually associated with granular kidney; it is dependent on the blood-vascular disease (arterio-capillary-fibrosis, Gull and Sutton), of which the kidney affection is only a part. The retinitis often appears before any sign of kidney mischief sufficient to attract the patient's attention is manifested, and it is the ophthalmic surgeon who first discovers the nature of the case. The urine need not be albuminous, but there is always evidence of increased arterial tension.

Leucæmic retinitis.—A peculiar form of retinitis, somewhat resembling the albuminuric, has been described as occurring in connection with leucocythæmia.

Leucæmic retinitis is marked by pallor of the optic disc, a peculiar rose colour of the retinal vessels, hæmorrhages, some opacity of the retina around the

optic discs, and white glistening spots similar to those met with in albuminuric retinitis, which, however, are situated in the peripheral parts of the retina.

Embolism of the retina.—A form of retinitis associated with plugging of the central artery comes on suddenly without apparent cause, with complete loss of sight. Ophthalmoscopic examination shows some pallor of the optic disc and diminution in calibre of the vessels emerging from it, but the most marked change is seen in the region of the yellow spot.

The retina around the spot is white or greyish-white and opaque, and numerous blood-vessels, not visible under ordinary conditions, arranged in a radiating manner round the spot, come plainly into view; the macula itself is seen as a bright red spot which might be taken for a hæmorrhage by a careless observer.

The bright red appearance of the macula arises from the anatomical arrangement of the parts; the retina in this situation, being thin and firmly bound down to the parts beneath, does not become infiltrated with inflammatory exudation, and consequently the normal red colour of the fundus appears in striking contrast to the surrounding opaque retina. Hæmorrhages may occur. Atrophy of the optic disc follows within three months.

Syphilitic retinitis is frequently associated with choroiditis. There are no ophthalmoscopic signs which will enable us to say with certainty that the changes seen are of syphilitic origin, in making a diagnosis other signs of syphilis must be taken into consideration. As in choroiditis there is often opacity of the vitreous.

The opacity of the retina is generally diffuse, but may be confined to the zone immediately surrounding the optic disc, or to the region of the yellow spot. The opacity varies from a slight smoky haze to dense white or yellowish-white.

The optic disc at first hyperæmic becomes hazy, the retinal vessels over full and tortuous. In favourable cases the opacity clears and the retina returns to more or less its normal condition; in unfavourable ones atrophy of the retina and choroid results.

Syphilitic retinitis may occur in either congenital or acquired syphilis, in the latter it is one of the secondary symptoms usually setting in from six to eighteen months after the primary disease, its course is extremely chronic and is often broken by relapses.

Diseases of the retinal vessels giving rise to plugging of small arterial branches and consequent loss of sight in the portion of retina supplied by them, is not uncommon in tertiary syphilis. The symptoms are losses of parts of the visual field; the ophthalmoscopic signs are not well marked. Recovery usually takes place under antisyphilitic treatment.

Treatment.—In all cases of retinitis both eyes should be kept thoroughly at rest, by prohibiting all near work, paralysing the accommodation with atropine, and shielding the eyes from the stimulus of too bright light by neutral tint or smoke coloured protectors. Everything that is likely to cause disturbance of the ocular circulation, as stooping positions, excitement, stimulants, too rapid variations of temperature, etc., should be carefully avoided.

Blood may be taken from the temples by leeches, or, preferably, by the artificial leech; blisters to the temples or behind the ears may be used. In syphilitic retinitis mercury does good; it should be given so as quickly to affect the system, either by the mouth, by inunction, or in the form of vapour baths. In long-standing cases, however, small doses of bichloride of mercury, taken regularly for some months, may be beneficial.

The other forms of retinitis are of only secondary im-

portance to the disease with which they are associated, and against which treatment must be directed (*see* Causes Retinitis). No treatment is of much avail in retinitis pigmentosa.

Atrophy of the retina may be the sequel of inflammatory changes. Its principal characteristic seen with the ophthalmoscope is a condition of bloodlessness, in some cases associated with opacity of the retina, and frequently with atrophic changes in the choroid. Bloodlessness shows itself in a diminution of the visible number, and also of the calibre of the retinal blood-vessels, more especially of the arteries, some of which may appear pervious to red blood-corpuscles in part of their course only, their continuations being marked by a yellowish-white cord. Opacities, if they occur, are of a greyish-white colour, and situated for the most part around the optic disc.

The disc itself is frequently extremely anæmic or atrophied. (For treatment of atrophy of the retina, *see* Atrophy of the Optic Disc).

Hæmorrhage into the retina.—Besides the form of hæmorrhage described as occurring in retinitis, bleeding may take place into the structure of the retina, from rupture of a retinal blood-vessel without previous inflammatory change. The hæmorrhage is usually considerable, and will be seen as an irregular patch of blood, situated somewhere in the course of the ruptured vessel, and often surrounded by inflammatory exudation. The patients are often young women, and the bleeding occurs at a menstrual period.

The extravasated blood becomes gradually absorbed, but usually leaves behind it some indications of its previous existence.

Treatment.—Rest of the eyes and protection from bright light, counter-irritation and mild purges.

Displacement of the retina is associated with the effusion of serous fluid, or blood, or the presence of a growth between it and the choroid. It almost always occurs in connection with disease of the choroid, ciliary body or vitreous. A blow on the eyeball or head may be the immediate cause of displacement, or it may occur spontaneously. Myopic eyes are more liable to suffer from retinal displacement than those which are emmetropic or hypermetropic.

Displacement of the retina occurs usually at its lower part, but may vary in extent from detachment of a small fold to total separation of the whole retina from the choroid, the only points of attachment left, being at the optic disc and ora serata.

Symptoms.—The symptoms of retinal displacement are sudden or rapid failure of sight, or the patient complains that a sudden mistiness came on and gradually increased; we shall probably be told that vision is better when first waking in the morning and becomes worse as the day wears on. An examination of the visual field will show a deficiency of some part, generally the upper, corresponding to the lower part of the retina; the patient will very probably say "I can see your chin and mouth, but cannot see your eyes," or make some such statement.

Detachment of the retina is best examined by direct ophthalmoscopic examination, the appearances depend much on the duration of the detachment. At first the retina retains its transparency, we notice an abnormal condition of the retinal vessels, some of them appear to move slightly, look dark instead of red, and are evidently out of place. As time goes on the detached portion of retina becomes opaque and appears as a dark grey, slightly movable fold, or cloud, over which the dark retinal vessels can be traced. Displacement of the

retina may be associated with other opacities in the vitreous.

A hæmorrhage or inflammatory deposit may be mistaken for a retinal detachment. A correct diagnosis can always be made by noticing the retinal vessels; if they can be traced over the grey cloud it is certainly a displaced retina.

The treatment of displaced retina is unsatisfactory. An attempt should be made to procure absorption of fluid by the administration of such drugs as iodide of potassium and mercury, and by the application of blisters to the temple or behind the ear. If the displacement occurs in connection with myopia, the anomaly of refraction should be carefully neutralised by suitable glasses; in all cases complete rest should be given to the eyes, so as to prevent as much as possible further detachment.

Perfect rest in the recumbent posture, the hypodermic injection of nitrate of pilocarpine so as to cause profuse sweating and salivation; puncture or trephining the sclerotic, so as to let out the subretinal fluid, have all been tried, but without any very satisfactory result. A quite recent detachment may subside with or without treatment, but one of long standing remains or gets worse.

Inflammation of the optic disc (optic neuritis, neuro-retinitis).—The ophthalmoscope shows a reddish-grey turbidity of the disc and the surrounding zone of retina, accompanied by swelling of the parts. The retinal veins are engorged, but their visible number is not increased; the arteries are thinner than usual, and all the vessels are more or less shrouded and concealed from view in the opaque portion of retina and upon the nerve-surface. Numerous small hæmorrhages may occur upon the disc and around it.

Ischæmia of the disc (choked disc).—Simple congestion has been (and still is by some) looked upon as distinct from optic neuritis. It would, however, appear that the difference is one of degree only. The ophthalmoscope shows great swelling and an intense red colour of the disc, its outline being entirely lost; there is, however, but slight swelling or opacity of the surrounding retina; small hæmorrhages are frequently seen on the nerve-surface. The retinal veins are enormously distended, their course extremely tortuous, and they may be varicose; their visible number is also considerably increased. The arteries are thinner than natural or of normal calibre; none of the vessels are shrouded or concealed from view, as in neuritis.

In many cases of neuritis sight is unaffected; in others vision is much impaired or reduced to perception of light only.

Optic neuritis may be looked upon as indicative of irritation of the nerves in some part of their course, as would occur in meningitis; or of obstruction to the venous circulation resulting from pressure directly on the main trunks, as in cerebral tumour, or from any form of disease whatever which causes *over-crowding* of the contents of the cranium. Neuritis is usually bilateral. Should it occur in one eye only it is probably due to some local disease, as tumour in the orbit, orbital cellulitis or periostitis.

Treatment.—Optic neuritis is of only secondary importance to the disease which gives rise to it; it is of much greater interest to the physician than to the oculist, as its existence enables him to diagnose cerebral lesion with great certainty. The cerebral lesion is, however, often syphilitic, and it may be laid down as a rule, seldom to be departed from, that optic neuritis calls for the administration of iodide of potassium or mercury in full doses.

Atrophy of the optic nerve may be the result of preceding neuritis, when it is called "consecutive atrophy;" or the atrophy may have commenced as such, and slowly progressed without inflammatory change, "simple atrophy." It may also come on after injury to the head, the history being that after a blow the sight of one eye was lost. At first the ophthalmoscope shows no change, but in about two or three months complete atrophy of the disc sets in. The cause is damage to the optic nerve behind the eyeball.

With the ophthalmoscope the atrophic optic disc is seen to be white or bluish-white in colour, frequently its margin appears irregular, and it may be cupped. The atrophic cup varies from the glaucomatous in not having steep sides, so that the vessels do not appear broken in their course as in the latter affection; it does not take in the whole nerve, but only its central part, which slopes gradually backwards; the vessels appear curved on the surface of the disc, but are not altered in calibre as in glaucoma. Atrophy of the retina frequently accompanies atrophy of the optic disc.

In cases of atrophy of the optic nerves vision is always much impaired; some patients with extremely white discs can count fingers, distinguish large letters, or even read ordinary print, but in the majority of cases vision is reduced to bare perception of light.

Treatment.—The treatment of atrophy of the optic nerves, especially if associated with a similar condition of the retina, is most unsatisfactory, and, indeed, almost hopeless. Should a certain amount of vision still remain, and no change have taken place for many months, we may safely assure our patient that he will retain what sight he has. The drugs which have been principally used are iron, either alone or in combination with nux vomica, strychnia taken by the mouth or injected

hypodermically, phosphorus, quinine, or other tonics, and opium in gradually increasing doses. Galvanism has also been employed.

CHAPTER XII.

Amblyopia, Amaurosis, and Functional Failures of Sight.

Blunt sight or amblyopia in one eye occurs in cases of squint. A squinting person in order to avoid the inconvenience of double vision suppresses the image in the squinting eye. After a time the perception becomes so dulled that objects are seen indistinctly or not at all with this eye, even when it is properly directed by exclusion of its fellow. Some improvement of sight may be brought about by systematic practice of the squinting eye by itself, the sound eye being closed.

Amblyopia in one eye may also occur from defective retinal image. Corneal nebulæ, congenital cataract, high degrees of hypermetropia and astigmatism are the chief causes. In the majority of cases the retina is not properly educated, but in some it is probably imperfectly developed. Practice of the defective eye in hypermetropia and astigmatism, aided by suitable convex, spherical, or cylindrical lenses, will, if commenced early in life and persevered with, cause some improvement; no improvement is to be expected if the defect be not treated till late in life.

A rapid or almost sudden loss of sight in one eye, accompanied by neuralgia on the same side of the head and face, and without change visible by the ophthalmoscope, is sometimes met with. The sufferers are generally young adults, the failure of sight is often attributed to exposure to cold, it may be due to reflex from carious teeth, or possibly to inflammation extend-

ing from the latter along the periosteum, and affecting the optic nerve at its entrance into the orbit. Mr. Nettleship suggests a "retrobulbar neuritis" as the cause.

Blistering over the mastoid or temple, with iodide of potassium internally, will usually effect a cure. But some cases end in atrophy of the optic nerve and blindness of the affected eye. Carious teeth must be stopped or removed.

Amblyopia from hæmorrhage.—In some cases of frequently recurring hæmorrhage extending over a long period as the bleeding from piles, or menorrhagia, serious impairment of vision may take place. The ophthalmoscope shows no change, or at most some pallor of the discs. Arrest of the hæmorrhage will cure the amblyopia.

Hemiopia or Hæmianopsia signifies loss of one half of the visual field; both eyes are usually affected, and as a rule the lateral halves of the field suffer. In the majority of cases the right or left lateral half of each field is lost, in some cases the temporal half of each field is lost, and in one case which I have seen the upper half of each field was wanting.

Loss of the right half of each field indicates loss of function of the left half of each retina, and is probably caused by disease of the left optic tract. Loss of the two temporal halves indicates loss of function of the nasal half of each retina, and may depend on disease of the anterior part of the chyasma. Hemiopia may be transient or permanent, some persons appear to suffer from it as a kind of migraine; the attack coming on rather rapidly, arriving at its height and then gradually disappearing, the whole lasting about half an hour and leaving behind it a general feeling of discomfort. Sometimes the edges of the dark portion of the field

are bounded by a bright zigzag line. Transient hemiopia is probably purely functional and is often associated with gastric disturbance.

Closely allied to the foregoing is a transient loss of sight of one eye; the symptoms are identical with those of transient hemiopia, with the difference that the whole field is lost, there being no perception of light for some minutes. In one case, which I have examined ophthalmoscopically during an attack, I found the retinal vessels, both arteries and veins, gorged with blood, and watched them return to the normal condition as vision was restored. In all these cases any anomaly of refraction should be carefully neutralised.

Permanent hemiopia may last for any time without change visible to the ophthalmoscope, in some cases, however, atrophy of the disc is present.

Hysterical amblyopia and amaurosis.—In some cases of hemi-anæsthesia, partial loss of sight or complete blindness (amaurosis) with dilatation and immobility of the pupil of the eye on the affected side occurs. Complete or partial loss of sight, in some cases associated with colour blindness in one eye, may also be met with in cases where no hemi-anæsthesia exists. In both classes of cases ophthalmoscopic examination shows all the ocular structures to be healthy, but often some anomaly of refraction is revealed. With the rare exception of some cases of hemi-anæsthesia the reflex action of the pupil both direct and indirect is normal.

In another class of cases irritative symptoms occur; there is photophobia with spasmodic closure of the lids; lachrymation and spasm of accommodation. Exmination reveals no corneal or other disease; one or both eyes may be affected, and the symptoms often follow some slight injury to the eye. The sufferers are usually young females (not children), but occasionally

well marked cases occur in boys about puberty. The prognosis is good.

Treatment.—The treatment in all cases of hysterical amblyopia or amaurosis should be to demonstrate clearly and firmly to the patient that there is nothing the matter with the eyes; all sympathy should be withheld, and a little judicious bullying practised. In cases where one eye only is affected the sound one should be tied up and the patient made to use that which is supposed to be blind. If any anomaly of refraction exist it should be corrected. The administration of drugs only tends to keep up the delusion.

Asthenopia.—In a much larger class of cases there occurs a certain weakness with inability to use the eyes, in spite of careful correction of anomalies of refraction if they exist. These cases may be all included under the head of asthenopia, accommodative or muscular.

The sufferers may be male or female, but are most frequently women about the time of the menopause. If males they may be of any age, and are nervous hypochondriacal fidgety creatures. The following is a good instance of the class of patient:—A gentleman about fifty, apparently in robust health, but according to his own account always ailing, was more particularly troubled about his eyes. He could not use them for any length of time, could not sleep in a room where it was possible for the least light to enter; his own bed room had every crevice stopped, and nothing would induce him to sleep out of it. He went about wearing the darkest smoke coloured protectors and said he could not bear to be without them. His vision was normal the only discoverable defect was ·25 D of hypermetropic astigmatism. He was ordered + ·25 cyl. light smoke to go about in and persuaded that he could do perfectly well without the nearly black protectors, and was given + 1·25 D sph. + ·25 cyl.

for reading. For months he complained that he could not bear the light, and could not read or write. He was persistently advised to go on using the glasses, and no change was made in spite of his assurance that he was getting rapidly worse. After about eighteen months he entirely recovered.

Treatment.—The treatment must be careful correction of anomalies of refraction and presbyopia. If the internal recti muscles are weakened, assistance must be given by the use of prisms or decentrated lenses. Glasses will not, however, give immediate relief.

The patients should have thorough rest for a time and then be encouraged to exercise the eyes, without straining or fatiguing them; thus if reading or working can be continued for fifteen or twenty minutes without discomfort, the patient should be instructed to read or work for a rather less period and then to rest for a few minutes before continuing. By degrees the eyes may be used for longer and longer periods, but never long enough to cause fatigue, until any reasonable amount of work or reading can be done without difficulty. Care must be taken that all work is done in good light, and when artificial light is used it must be bright and steady. The patient should be encouraged to forget the eyes, to take plenty of out-door exercise and do all that is possible to keep up the general health. Ovarian, uterine, and digestive troubles should be treated, and men should be warned against sexual excess.

Toxic amblyopia.—Excess in the use of some substances as tobacco: over doses of some drugs, quinine; the prolonged exposure to the fumes of some chemical substance, bisulphide of carbon, chloride of sulphur, and also the poison of malaria may cause amblyopia or complete amaurosis. Tobacco amblyopia is the only one which need be specially described in a work of the present scope.

Tobacco amblyopia is characterised by a slowly progressive blunting of sight in both eyes, amounting in a few months to inability to read letters less than J. 20 at a few inches. In the early stage beyond the failure of sight there are no local symptoms, and ophthalmoscopic signs, if they exist, are not sufficiently pronounced to be of any value. Later the disc becomes markedly pale, especially at its outer side (that towards the yellow spot).

The defect of vision is limited in most cases to the central part of the retina; what is known as central "scotoma" (an area over which vision is lost or greatly diminished) being developed.

The persons affected are almost invariably men; they are generally from forty to fifty-five years of age, have smoked or chewed, or done both to excess ($\frac{1}{2}$ oz. or more of strong tobacco per diem) for some years, and have often drunk hard and lived dissipated lives as well. These last, however, are not necessary to the development of the disease, indeed some authorities affirm that drink rather retards it. Such is not my experience, many of the cases of "tobacco amblyopia" I have seen have occurred in confirmed "rips."

Treatment.—The treatment is simple to prescribe but not so easy for the patient to carry out. He must give up tobacco in every form, and generally mend his ways. It is our duty to point out in the strongest terms that blindness will result if tobacco is continued. Medicines do no good, but a "placebo" may be ordered if deemed advisable. The prognosis is good if no visible change has taken place in the disc, and even in some cases of marked pallor recovery may take place.

Traumatic amblyopia.—Blows upon the eyeball sometimes cause amblyopia or amaurosis. The pupil is dilated and all reflex abolished, and all perception of

light may be lost. The ophthalmoscope shows no change. Recovery of sight usually takes place after a time; no treatment beyond giving rest to the eye is required.

Functional Failures of Sight.

Functional disturbances are numerous and their nature is ill-understood.

Micropsia and Megalopsia.—Objects appear too small or too large. When not caused by altered conditions of accommodation and convergence, these disturbances may be due to misplacement of the rods and cones of the retina from inflammatory exudation, or to some affection of the nerves causing them to act discordantly.

Metamorphosia.—In which objects appear distorted, may be caused by an oblique position of some groups of rods and cones, consequent on inflammatory exudation, retinal detachment or progressive posterior staphyloma.

Colour-blindness (achromatopsia) may be congenital or acquired. If acquired, it depends on disease of the optic nerve, or may be a part of hysterical amblyopia. Congenital colour-blindness is usually discovered accidentally, or when systematic investigation is made as in examining signalmen, sailors, etc.

Reseaches made in this country, on the continent and in America, show that from three to five per cent. of the male population are more or less colour-blind; this fact should be borne in mind by all who have the examination of railway servants and others whose duty it is to distinguish coloured signal lights.

Colour-blindness is rarely complete, but the perception of certain colours is much limited or absent. Thus

red and green may be confounded together, but yellow and blue can be distinguished from each other and from red and green; or yellow and blue may be indistinguishable from each other, but red and green can be recognised. Red-green blindness is the commonest form of achromatopsia.

The methods of testing the colour sense are numerous, but the confusion test given at p. 50 is perhaps as good as any and is very simple. Tests which require colours to be named are not good, as many people who can quite well distinguish colours, and even pick out slightly differing shades of the same colour, do not know what to call them.

Coloured vision.—Objects appear red, green, yellow, etc., their real colour being changed. In some cases of jaundice objects appear yellow, from circulation of the colouring matter of bile through the transparent parts of the eye. In poisoning by santonin yellow or violet vision, the former in bright light, the latter in dull light, may occur.

Blue or leaden vision occurs after cataract extraction; patients complain that the hand, for instance, looks like a dead hand. It is said to be caused by the presence of cortical substance in the pupil; it passes off with time. Coloured vision is complained of in some cases of high degree of hypermetropia and in astigmatism; it probably depends on diffusion of light in the dioptric media, due to imperfect accommodation.

Night blindness.—A person suffering from night blindness is unable to see in dull light, the loss of sight being much greater than can be accounted for by the diminution of light, whilst in daylight or bright artificial light his sight is normal. Its cause is constant exposure to very bright and dazzling light either direct or reflected, thus sailors who are exposed in the tropics for

many hours a day to direct sunlight and light reflected from the water are liable to suffer. Soldiers may also be affected when exercising for many hours a day under a burning sun, especially upon white soil. Night blindness is also a prominent symptom in retinitis pigmentosa.

Snow blindness or ice blindness is of the same nature, but in addition to the want of sight there is conjunctival congestion, photophobia and pain, and in some cases conjunctival ecchymosis.

Muscæ volitantes appear as small dots, filaments, or webs, generally transparent, but at times quite dark or even black; they move about in the visual field and do not interfere with vision; they are, however, a source of considerable discomfort and sometimes of anxiety to nervous patients. They are always seen most distinctly in bright light and upon a light surface as when looking at white clouds or white paper, or the pavement in walking.

Muscæ are due to minute changes in the transparent media or films of mucous on the cornea; they are most common in myopic eyes; if they cannot be seen with the ophthalmoscope their presence is of no importance and patients may be assured that they will do no harm.

Malingering.—Patients sometimes wilfully feign blindness of one or both eyes, but are easily detected. If one eye only is affected its pupil acts freely both directly and indirectly; if we put a prism base up or down in front of either eye, the sound one for choice, double images appear, and the patient believing them to be caused by the glass mentions them at once. If a prism is not at hand, double vision can be produced by pressing on the sound eye with the finger so as to make it deviate in any direction. If atropine is applied to the sound eye when it has fully dilated the

pupil and paralysed the accommodation, the patient will read small print easily which of course must be done by the supposed blind eye. This test and that of the action of the pupil will be of no use if the patient has used a mydriatic to his supposed blind eye.

If both eyes are affected we shall soon find out the imposture by watching the patient; he will move about without running against objects, his pupils will act freely; if spoken to suddenly, or if a light be unexpectedly thrown upon the eyes he will give some sign that he sees.

The treatment of functional diseases of the retina, so far as treatment is of any avail, consists in the removal of the cause. Constitutional diseases should be treated, anomalies of refraction corrected, and the surroundings of the patient altered.

PART II.

OPERATIONS.

CHAPTER I.

Position of Patient and Operator, Administration of Anæsthetics, Use of Cocaine, etc.

All the minor operations, such as slitting the canaliculi, passing probes down the nasal duct, opening tarsal cysts, &c., can best be performed when the patient is seated in a chair, and the operator stands behind him; the patient's head, over which a towel has first been thrown, resting against the operator's chest. (*See* Fig. 31).

The more important operations, as extraction of cataract, iridectomy, squint, etc., should be performed whilst the patient is lying on a hard couch, his head resting on a bolster covered by a towel, thrown forward over the forehead; the operator should sit or stand behind (*see* Fig. 32). In whichever position an operation is to be performed, the chair or table should be placed in front of a large window so as to insure a good light, and care be taken to prevent assistants and others from interposing their heads or bodies between the patient's face and the source of light. It will be found whilst operating that, with the exception of occasional pronation and supination, there is little occasion to use the arms, which should be kept with the elbows near the sides, the wrists resting on the

patient's head or face, in a position which allows of free movements of the hands and fingers.

Every ophthalmic surgeon should learn to use his fingers, cultivate his sense of touch, and, if possible, become ambidextrous.

FIG. 31.—Position for minor operations. (Sitting).

FIG. 32.—Position for major operations. (Lying).

(*From* Byrant).

It will be found that incisions can be best made by holding the knife lightly between the thumb and first two fingers of whichever hand is most conveniently situated.

In all operations, incisions commencing at, or situated entirely on, the outer aspect of the globe should be made with the hand corresponding to that side, the opposite hand being employed upon the inner side. That is to say, if the right eye is operated on, the right hand should be used to make an incision at its outer side, the left at its inner, and *vice versâ*.

Incisions above or below may be made with either hand; scissors should also be used with whichever hand is most favourably situated.

In one operation, that for internal strabismus, the positions of patient and operator are somewhat different from those already described, the operator standing in front, at the side of the couch on the patient's right, instead of behind his head.

The scissors may be used with the right hand for both eyes, but in operating on the left the hands will have to be crossed.

Before performing any operation the operator should look carefully to the condition of the instruments he is about to use and see that they are washed in an antiseptic solution. Knives should be passed through a piece of thin leather tightly stretched on a small metal cylinder, and care taken to ascertain that they have good points and that there are no notches in the blades.

Scissors should be carefully examined and tried; it should be seen that forceps close properly, and are free from rust or dirt; silk for sutures should be black, as fine and strong as possible, well waxed, and free from flaws or kinks. Inattention to these details may very possibly mar the success of an operation.

Antiseptics.—The antiseptic treatment is not applicable to ophthalmic surgery further than the cleansing of all instruments and sponges with 1 to 20 solution of carbolic acid, the soaking of all dressings in boracic acid solution gr. x. to ℥ j. and cleansing the eye with the same.

Administration of anæsthetics.—The operator will find that he has much more command over the eye when the patient is under the influence of an anæsthetic than when consciousness remains and in a great number of cases he will do well to administer one. It must, however, be born in mind that in all cases where a large incision has to be made into the globe, as in cataract extraction or iridectomy for glaucoma, *the*

anæsthesia must be profound; a partially anæsthetic condition is worse than no anæsthesia at all, on account of the straining which is sure to take place. In operations for squint or in those where only a small incision is made as in iridectomy for artificial pupil profound anæsthesia is not necessary.

Occasionally patients are met with who will bear operations most quietly, such should be operated on without anæsthesia; but if during the operation the patient becomes unsteady, or begins to strain, it is best not to risk failure, but to discontinue the operation and administer an anæsthetic. If the globe has been opened, it must be carefully guarded by a pad and bandage during the administration. When no anæsthetic is employed the operation should be performed as simply and quickly as possible; no speculum should be used, nor should the eye be fixed with forceps, but the operator should keep the lids open, and steady the globe with the fingers.

Cocaine, an alkaloid prepared from the leaves of Erythroxylon Coca, has lately been introduced as a local anæsthetic and is of great value in ophthalmic practice. The salt which has been found most useful is the hydrochlorate. A solution of $2\frac{1}{2}$ per cent. (or stronger if desired) dropped into the eye causes anæsthesia of the conjunctiva and cornea in the course of a few minutes. Blanching of the conjunctiva, retraction of the upper lid, some dilatation of the pupil and weakening of the accommodation also occur.

The operations in which cocaine is useful are those affecting only *the conjunctiva and cornea;* it has little or no effect upon the deeper parts; consequently it is of little use in iridectomy and opening tarsal cysts beyond the first incision, the removal of the iris or scooping out of the cyst causing nearly as much pain as if no application

had been made. Neither does it entirely deaden pain in slitting the canaliculi or passing lachrymal probes, or in division of the tendon in squint operations. But for removal of foreign bodies from the cornea, or sutures from the conjunctiva, all operations on the conjunctiva, corneal incisions as for extraction of cataract *without iridectomy*, and needle operations, cocaine is invaluable.

Cocaine is also useful where the cornea is abraded from injury or is the seat of painful ulceration, and in cases where there is difficulty in examining an eye from pain or intolerance of light.

The method of using it is simple; the solution should be dropped into the eye three times or oftener during five minutes immediately before the operation is commenced, the effect lasts from ten to fifteen minutes; if sensation begins to return before the operation is finished, more of the solution should be applied.

Disagreeable symptoms have been brought about by its use, but the cases are few. Mr. Nettleship has reported a series of cases in which he believed that suppurative ophthalmitis was set up by the use of cocaine. Great care should be taken that the solution is fresh, and none should be used which has become turbid from the formation of fungus. My own experience is that cocaine applied too freely or in too strong solution may be the cause of suppuration following an operation. Thus in a case in which cocaine was applied many times for an hour before operating, the cornea became steamy and suppuration quickly followed an extraction of cataract. The untoward result in this case was, I believe, due to destruction of vitality and not to septic influence.

After-treatment.—Operations on the tear passages, tarsal cysts and strabismus, require little or no after-treatment; the parts need only to be washed twice or three times a day with tepid water.

After more severe operations on the eyelids, and in all cases where an incision has been made into the globe, the eye should be carefully covered with two small folds of lint, wetted with boracic acid lotion (gr. x. to ℥ j.) and secured by a single turn of bandage, the lint being kept wet and the eye bound up until the incision has healed and all irritation subsided. Wounds of the globe made in operations, as a rule, heal rapidly, union having frequently taken place at the end of twelve hours.

Sponges should rarely be used and are seldom required, except in cases of extirpation of the eyeball or plastic operations about the lids; small pledgets of absorbent cotton wool which have been soaked in boracic lotion answer every purpose.

The great danger after operations on the globe is the occurrence of inflammation.

Inflammation, once set up, may subside shortly, leaving no trace behind it; it may continue until more or less irreparable damage has been done, or may run on to suppuration of portions or the whole of the globe; the cornea is more liable to this change than any other structure.

The symptoms of inflammation usually appear within the two days immediately succeeding an operation, and little fear need be entertained for the safety of the eyeball if all has gone well for a week.

Occasionally, after cataract extraction, eyes have been lost through inflammation, or suppuration, commencing at a later period, but these cases are rare, and probably it will be found that some damage has been done to the eye shortly before the symptoms appeared.

The treatment of inflammatory changes consists in the local abstraction of blood from the temple by leeches, or the application of the artificial leech; the

use of fomentations of water, poppy-heads, or belladonna constantly applied, or the application of the hot coil (*see* DISEASES OF CORNEA); together with the administration of opium in full doses, either alone or combined with mercury. The treatment must, of course, be varied according to the condition of the patient; should he be weakly and anæmic, we should be careful about blood-letting, and prescribe instead quinine and iron, with good living and a fair amount of stimulants.

The local abstraction of blood, however, acts most beneficially in relieving pain, and should therefore be employed in cases where pain is a prominent symptom, even though the patient does not appear to have much blood to lose. Strong healthy patients should be leeched freely, and kept on light diet.

During the treatment the eye must be kept carefully closed and bandaged, excepting during the time that fomentations are being applied. Moderate pressure by carefully applied pads of lint and cotton wool, secured by a few turns of flannel bandage, is said to exert considerable influence in cases where the cornea is threatened by suppuration; it should have a fair trial, if pressure can be borne.

If the inflammation goes on to suppuration of the whole globe the case must be treated in the same manner as abscess in any other part (*see* OPHTHALMITIS).

Insertion of a seton in the temple.—In order to place a seton in the temple, the position of patient and operator should be as in Fig. 31, p. 204. The operator should pinch up the skin with the finger and thumb of one hand, just in front of and above the patient's ear, and pass a seton needle armed with a double thread of stout silk through the fold thus produced; the silk should be drawn through and tied in a loop long enough to go round the patient's ear. The seton should pass for

about $1\frac{1}{2}$ in. beneath the skin, and should be placed amongst the hair, so as to avoid as much as possible disfigurement from the subsequent cicatrix; the silk should be drawn backwards and forwards through the wound every morning, and may be left in as long as appears necessary.

Care must be taken in passing the needle not to wound the temporal artery; should this accident happen the seton must be removed and firm pressure applied with a pad and bandage.

Application of the artificial leech.—This instrument consists of a small sharp steel cylinder (worked by a spring arrangement), with which a circular incision can be made through the skin of the temple, and a hollow glass cylinder, which can be placed over the wound, and the air in its interior exhausted by a piston worked by a screw; as the air is removed the blood flows up to fill the vacuum. Care must be taken not to work the screw too quickly, but only to move the piston at the same rate as the blood flows; and the edge of the cylinder must not be allowed to compress the skin against the parts beneath, otherwise the flow of blood will be impeded. The skin should be well greased, and hair which may be in the way removed before the application of the cylinder.

CHAPTER II.

The Eyelids, Lachrymal Apparatus, and Conjunctiva.

Tumours.—Various small growths are met with about the eyelids.

Molluscum occurs as a small yellowish-white projection, having a depressed and often blackened centre, on some part of the skin of the lids; there may be only one or many of these little growths. They can be easily removed by thrusting a knife through them, and then squeezing out the contents between the thumb nails.

Dermoid cysts are not unfrequently met with situated deeply beneath the skin and the muscle, often near the outer angle of the orbit. They are congenital, filled with sebaceous matter, and often contain hair. They must be carefully dissected out, much more trouble being experienced in so doing than would be at first suspected, and they will in all probability be opened during removal. These little tumours will be found attached deeply to the periosteum, and may have caused a depression in the bone.

Warts are not unfrequently met with about the eyelids; they should be cut off with scissors.

Tarsal or Meibomian cyst occurs as a dusky red or colourless projection from the outer surface of the lid; its position is marked on the conjunctival surface by a bluish spot, from which a granulation is occasionally seen growing. The cyst is formed by obstruction of a Meibomian gland and retention of its secretion; it is sometimes in a suppurating condition.

The lid should be everted, the cyst freely opened from

the conjunctival surface with a small knife, and its contents squeezed or scooped out; it must be thoroughly emptied, or it will, in all probability, re-form.

The cavity left on removal of the contents of the cyst will always fill with blood, and shortly after the operation the tumour will be as large or larger than before; the patient must be warned of this.

The swelling will most probably disappear in the course of from four to six weeks; if it remains longer the operation should be repeated.

A tarsal cyst sometimes degenerates into a hard fibrous little mass, feeling somewhat like a shot beneath the skin, known as a *chalazion;* this should be dissected out through an incision in the skin of the lid, which should afterwards be closed by a fine suture.

Xanthelasma is often met with as a small slightly raised yellow patch or patches on some part of the skin of the eyelids; its most frequent site is the surface of the upper lid near the inner canthus. The little patch may be excised if it is a source of anxiety to the patient. In some cases the patches increase until they form a continuous ring around the eye. Patients affected by xanthelasma are often very subject to bilious attacks and there appears to be some relation between the skin affection and hepatic trouble.

Simple serous cysts occur about the margins of the lids; they are about the size of small peas, and nearly transparent. A portion of the cyst wall should be cut out with scissors.

Trichiasis signifies a faulty direction of the eyelashes, (generally those of the upper lid) which turn inwards and irritate the cornea; it is usually caused by contraction of the conjunctiva (following granular ophthalmia or its unskilful treatment), producing displacement of the hair follicles.

Only a few lashes or the whole row may be inverted. If only a few of the lashes turn inwards, it is sufficient to pull them out with forceps made for the purpose and known as "cilium forceps," whenever they become troublesome. In pulling out lashes care must be taken to draw them out straight and not to pull them to one side and break them off; two or three may be pulled out together and when the bulk have been removed those remaining should be carefully picked out one by one. If a considerable number or the whole row

FIG. 33. Compressorium forceps.

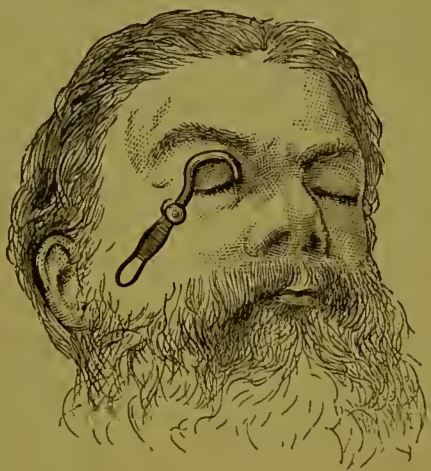

FIG. 34. Compressorium forceps applied.

(*From* Bryant).

are inverted, their roots should be removed by operation. The operation should be performed as follows:—The patient being placed in the usual position (*see* Fig. 32, p. 204), the lid should be secured by a compressorium forceps (Figs. 33, 34), by which means it is steadied and hæmorrhage prevented; care must be taken not to screw the instrument up too

tightly, or sloughing of the lid may follow. The lid being well secured, the operator should make an incision through the skin, about two lines from the free margin of the lid and parallel with it, of such a length as to correspond to the lashes which are misplaced; the incision should be carried down to the outer surface of the tarsal cartilage; a second incision should then be made of the same length as the first, in the margin of the lid, and so conducted as to split the lid and separate the skin and hair-bulbs from the subjacent structures; the ends of the two incisions should then be joined by two short cuts, and the portion of skin included with the hair-bulbs dissected off the tarsal cartilage. The raw surface should then be wiped with a sponge, and any black dots denoting the presence of hair-bulbs carefully removed.

The compressorium forceps should then be unscrewed, when sharpish hæmorrhage will take place. The eye must be covered by two pieces of wet lint secured by a turn of bandage.

The whole row of lashes may be transplanted as follows:—The lid being secured by the compressorium forceps, an incision should be made through skin and orbicularis muscle along the whole length of the lid, parallel to and about two lines from its margin; a second lunated incision joining the extremities of the first and including a portion of the surface of the lid about two lines in width should then be made, and the portion of skin and muscle marked out by the two incisions dissected off the tarsal cartilage. The next step in the operation is to separate the portion of lid carrying the lashes, from the tarsal cartilage leaving it attached only by its extremities, then slide it up over the surface of the lid and fix it in the gap already prepared by as many sutures as may be necessary; the raw surface left by separating the

portion of lid with the lashes may be left to itself and will heal by granulation. Boracic lotion dressing alone is required. If the operation has been skilfully performed, the row of lashes will be directed forwards away from the globe, after cicatrization has taken place.

This operation may be modified as follows:—Instead of a lunated incision make one parallel with the first, separate the portion of skin and muscle included between the two, and instead of removing it, make it and the portion of lid containing the lashes change places by drawing the former downwards beneath the latter and fixing it over the raw surface by as many sutures as may be necessary.

Entropion signifies a rolling inwards of the whole lid, the whole row of lashes being completely turned towards the eyeball. It is most frequently met with in the lower lid, more especially in old people with a superabundance of loose skin about the face, and is often the cause of much trouble and annoyance, as well as of danger to the eye, after cataract extraction.

The inversion is caused by spasmodic contraction of the orbicularis muscle or by distortion and thickening of the tarsal cartilage after granular ophthalmia.

Entropion caused by contraction of the orbicularis is easily remedied as follows:—The patient, lying on a couch (*see* Fig. 32, p. 204), the operator should seize with forceps the skin of the lid at a point near one or other canthus, about two lines from its margin, and then with scissors remove a portion in breadth corresponding to about half the surface of the lid, and extending along its whole length; he should then seize and remove the orbicularis muscle to a corresponding extent. No suture need be used; the eye should be bound up with lint wetted with boracic lotion and a bandage. The subsequent healing of the wound and contraction of the cicatrix will remedy the inversion.

Entropion depending on distortion and thickening of the tarsal cartilage is usually met with in the upper lid. It can be remedied by removal of a wedge-shaped piece of cartilage, including the more thickened portion, by the following operation:—The patient, being in the usual position (*see* Fig. 32, p. 204), and the lid fixed by a compressorium forceps, an incision should be carried through its whole thickness, parallel with and about two lines distant from its margin, along the whole extent of the thickened portion. A somewhat lunated incision should then be made from one end of the first around the base of the thickened portion of tarsal cartilage joining the first incision at its other extremity; the second incision should not be carried vertically through the cartilage, but obliquely, so as to meet the first at the conjunctival surface; the portion of cartilage included between these incisions should then be removed, the wound closed by sutures, and the eye bound up with lint and a bandage. The skin and muscle covering the cartilage may be removed or not, according to the fancy of the surgeon. If their removal is not desired, they should be dissected back before making the second incision. After the operation the margin of the lid should appear rightly directed.

Ectropion signifies an everted condition of the lid; the extent of eversion varies in different cases, from slight falling away of the margin of the lid from the globe to eversion of the whole extent of the lid and adjoining fornix of the conjunctiva.

The slighter forms are caused by distension of the lid from inflammatory swelling or from general laxity of tissue as seen in old people, and are easily remedied by slightly narrowing the palpebral aperture, by paring the edges of the lids near the outer canthus, and bringing the raw surfaces together by a suture, when firm union will take place between the two (see p. 220).

The more extreme forms are caused by the contraction of cicatrices of burns, wounds, or inflammatory changes, about the orbit.

No definite rules can be laid down with regard to the treatment of these cases. The surgeon must be guided by the conditions as they present themselves, and do the best he can.

In any case, if the tarsal cartilage is left entire, it should be carefully dissected away from its abnormal attachments and replaced as nearly as possible in its proper position, and kept there by paring its margin and that of the opposite lid and uniting the two by sutures so that extensive and firm union may take place between them. Then if there is any healthy skin adjoining, a flap should be dissected up and made to cover the raw surface left by freeing the cartilage; or a V or curved incision may be made in a suitable position and the tissues shifted as required; in all cases any fresh raw surfaces made should be covered by skin. The lids must not be opened until all contraction of the original cicatrix or of cicatrices made in operating is at an end, the time allowed should not be less than six months, and it is better to leave the eye closed for considerably too long a period than to open it a day too soon. Ectropion is also frequently seen in the more severe forms of ophthalmia, or in cases of severe intolerance of light, and is specially liable to occur when an attempt is made to open a firmly closed eye. In these cases the eversion requires no special treatment, but disappears as the affection causing it is recovered from.

Formation of a new eyelid.—In some cases of burn, or severe ulceration more or less complete destruction of the eyelids takes place. To remedy this defect, a flap of skin from a neighbouring part may

be brought, placed in the gap, and there secured by means of sutures, care being always taken that the piece of skin is considerably larger than the surface it is intended to cover. Before removing the skin, search must be made in any portion of the eyelid that may be left for the tarsal cartilage, and if this is found it must be carefully dissected out and preserved, its natural form being as much as possible restored; it should be fixed in its proper position by uniting its margin to that of the opposite lid. Even if no flap of skin is applied over it, it will in time become covered with cuticle, and form a very effectual covering to the eyeball.

Symblepharon signifies adhesion of the conjunctiva of the eyelid to that of the globe. It is usually caused by burns with lime or hot metal, and may occur to any extent, varying from a thin band of union to fusion of the greater part or whole of both lids with the globe.

This condition requires to be remedied by operation. Where only a thin band of adhesion exists it should be first carefully secured by a suture passed through the extremity nearest the eyeball and then be divided, and drawn into the fornix by passing the suture through the lid and securing it to a small roll of strapping, placed upon the cutaneous surface. By this means the raw surface left by removal of the band from the globe is brought into contact with healthy conjunctiva and granulates over, healing without forming adhesions.

If more than one band exist each should be dealt with separately.

Cases of more extensive adhesion give rise to the utmost difficulty in treatment, and the operations performed for their relief have been attended with only indifferent success. One plan of treatment re-commended was to dissect away the adhesion and

interpose a shell of glass between the raw surfaces, but as healing invariably commenced at a point remote from the free margin of the lid, the shell was gradually pushed out and the adhesion re-established.

The insertion of pieces of wire deeply beneath the adhesion, and leaving them in until the walls of the canal made by them had healed, the remainder of the adhesion being then divided with scissors, was followed by no more satisfactory results.

Some few years ago, an operation was introduced by Mr. P. Teale, of Leeds, which has been attended with the best success. The operation has for its object the separation of the raw surfaces by a piece of conjunctiva, taken from some other part of the eyeball. The following is an extract from the account of the operation given by Mr. Teale in the *Transactions of the Fourth Ophthalmic Congress*, 1872. "The patient being under the influence of an anæsthetic, the eyelid is freed from its attachment to the lid; next, a band of semi-circular form is marked out, with a sharp knife, upon the sound conjunctiva; the band commences at one end of the gap left by liberation of the lid, and passes round the sound side of the cornea, terminating at the opposite extremity of the gap.

"Four stitches are then inserted, two on each edge of the flap thus formed. The flap is next separated on its *under surface*, whilst its extremities are left continuous with the conjunctiva; it is then drawn across the surface of the cornea, and fixed, raw surface downwards, into the gap formed by the liberation of the eyeball from the lid; it is secured in its new position by the sutures already alluded to, aided by as many others as may appear necessary."

Mr. Teale states that "the operation is most tedious," and that he rarely completes it within the hour.

Anchyloblepharon signifies an adhesion of the lids to each other. The adhesions must be divided with scissors, and the skin and conjunctiva united so as to cover the raw surfaces; but if this cannot be done, reunion may be prevented by passing a probe between the lids daily.

Narrowing of the palpebral aperture (Blepharophymosis) is usually a result of granular ophthalmia, and is accompanied by entropion, displaced tear puncta, and consequent watering of the eye. It requires to be remedied by operation, which can be thus performed:—The lids being kept widely open and on the stretch by a wire speculum (Fig. 35) an incision should be made with strong scissors through the outer canthus. A flap of conjunctiva, of somewhat conical shape, should then be marked out on the surface of the eyeball, the flap freely dissected from the subjacent structures, but left attached at its base, which is towards the cornea, and then fixed by sutures in the incision made by the scissors, in such a manner as to keep the raw edges separated by a mucous surface.

FIG. 35.—Wire speculum.
(*From* Bryant).

Tarsoraphy.—It is sometimes necessary to narrow or close entirely the palpebral aperture. This operation, known as *tarsoraphy*, can be performed as follows:—The lid being held with forceps, a portion of *the inner edge* of its margin should be removed with a small iridectomy

knife, care being taken not to cut away any of the outer edge containing the lashes, nor to wound the tear puncta or canaliculi. The opposite lid should then be treated in the same manner, and the raw edges brought together by sutures; firm union will soon take place between them.

Ptosis signifies a drooping of the upper eyelid to a greater or less extent, with inability to raise it. Ptosis occurs with divergent strabismus and more or less impairment of the mobility of the eyeball, in cases of paralysis of the third nerve, and is generally, but not invariably, accompanied by dilatation and fixity of the pupil (see p. 107). It is also met with as a congenital defect, and sometimes occurs after severe inflammation of the lid, or protracted intolerance of light, and constant spasmodic action of the orbicularis muscle. Women past the middle period of life, with a superabundance of loose skin about the face, are also subject to a form of partial ptosis.

Treatment.—In ptosis from paralysis of the third nerve, treatment must be directed against the cause of the paralysis, no operation being advisable; other forms can be remedied by removal of some skin and orbicularis muscle from the surface of the lid.

This operation may be performed as follows:—The skin at the upper part of the lid should be pinched up with forceps, the amount included between their blades being such as to raise the margin of the lid well above the upper border of the pupil. Then with scissors a strip of skin of the required width should be removed, along the whole extent of the lid, parallel to its margin; and the orbicularis muscle should be cleanly dissected off the tarsal cartilage to about the same extent, the wound closed by one or two fine sutures, and the eye bound up with wet lint and a bandage.

The wound will heal in the course of a few days, and the shortening caused by the removal of the skin and muscle, and subsequent cicatrization (possibly aided by the entanglement of some fibres of the occipito-frontalis in the scar) should keep the lid in the desired position.

In cases of congenital ptosis we often find movement of the eyes upwards greatly impaired; it seems probable that the superior rectus is badly developed or altogether absent.

The Lachrymal Apparatus.

The lachrymal gland is occasionally enlarged from chronic inflammation, or is the seat of malignant or other growths, and may require extirpation through an incision in the skin over the most prominent portion of the swelling.

A cyst is sometimes met with caused by obstruction of one of the ducts of the gland and accumulation of secretion. The disease is known as *dacryops.*

Its treatment consists in establishing an opening into it from the surface of the conjunctiva; this is easily done by passing a curved needle armed with silk from beneath the upper lid through the wall of the cyst into its cavity, and out again at a convenient distance; the silk should then be drawn through, and the portion of cyst-wall included between the entrance and exit of the needle firmly ligatured; the ligature will slough out and leave a permanent opening, causing no inconvenience. If the cyst be opened through the skin it may leave a troublesome fistula.

The tear puncta and canaliculi.—The tear puncta in the normal condition lie in contact with the ocular conjunctiva; they may be either everted, as seen in old and neglected cases of tinea, or rolled

somewhat inwards; they are sometimes entirely obliterated, either by disease or injury, burns of the eyelids being the most common cause.

The canaliculi may also be strictured, or more or less obstructed in any part of their course, by cylindrical or spherical concretions consisting chiefly of fungus. All these conditions are accompanied by troublesome watering of the eye, "epiphora." They can be remedied by slitting the tear puncta and canaliculi.

The lachrymal sac is often the seat of acute inflammation, which may arise in the sac itself, spread to it from the conjunctiva, or be caused by disease of the surrounding bones. It is characterised by a dusky-red tense swelling, situated at the side of the nose, close to the inner canthus, the swelling and redness often extending outwards along both the upper and lower lids; one or both sacs may be affected. The inflammation may end in resolution or go on to the formation of an abscess; in the latter case, the swelling becomes soft and fluctuating.

Treatment.—At first, hot fomentations and poultices must be applied, and attention paid to the general health; if abscess form, the pus must be let out by a free incision through the skin. If an abscess of the lachrymal sac is allowed to burst a fistulous opening will very probably be left, but if a free opening is made so soon as the formation of pus is suspected, the wound heals readily.

Distention of the lachrymal sac (Mucocele).—The lachrymal sac not unfrequently becomes distended, forming a tumour of varying size beneath the internal palpebral ligament (tendo oculi); pressure on the tumour causes the escape, through the tear puncta, of a transparent, somewhat tenacious fluid, consisting of mucus and tears, in some cases thickened from the ad-

mixture of pus-cells. Distension of the sac is caused by stricture of the nasal duct and consequent accumulation of secretion; it is accompanied by more or less watering of the eye, and may be remedied by relieving the stricture of the duct.

Discharge from the lachrymal sac (Blennorrhœa).—A muco-purulent or purulent discharge from the sac is often met with, following inflammation, especially if disease of the adjacent bone exists. It may be treated—1. By insuring a free exit for the discharge by slitting the canaliculus, and passing a large probe down the lachrymal duct. 2. By washing out the sac. 3. By obliteration of the sac.

Stricture of the nasal duct may be met with in any part of its course; the obstruction, however, is most frequently found at its junction with the lachrymal sac. Occasionally the duct is found almost obliterated by dense bony deposit.

Fistula of the lachrymal sac occurs as a small, sometimes scarcely perceptible opening, situated at some point over the sac; it is caused by the bursting of an abscess of the sac and is generally associated with obstruction of the nasal duct. If the passage is re-established, the fistula will probably close.

Operations on the tear passages.—The operation of slitting the tear puncta and canaliculi may be performed thus:—The patient should be seated in a chair, the operator standing behind him (see Fig. 31, p. 204). Supposing the lower punctum and canaliculus on the right side to be operated on, the small and ring fingers of the left hand should be placed upon the patient's face, near the outer canthus, the lids drawn tight, with these two fingers, and kept so; then a small grooved director (Fig. 36) should be taken in the right hand and passed at first vertically to the

margin of the lid, through the tear punctum; its handle then depressed, and its point passed horizontally along the canaliculus into the sac. To ascertain that the point of the director is in the sac, the tension of the lids must be relaxed and the director pushed gently onwards; if there is any puckering at the inner canthus when the director is thus pushed, its point has not entered the sac, and a further attempt must be made; if no puckering occur the lids should be brought again into a state of tension, and the handle of the director transferred to the thumb and forefinger of the left hand; a cataract or any small knife that will cut should then be taken in the right hand, and run along the

FIG. 36.—Grooved director for slitting canaliculus.

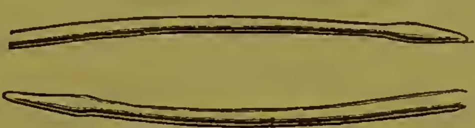

FIG. 37.—Lachrymal duct probe.

groove of the director well into the sac, the knife and director being then withdrawn together; the upper lid must be kept out of the way by one of the fingers of the right hand. The operation can be performed on the left side in the same manner, with the exception that the hands are reversed.

The upper punctum and canaliculus sometimes require to be slit; this operation is not quite so simple as that on the lower lid, but is performed in much the same way. In lieu of the grooved director and knife, a small probe-pointed canaliculus knife may be employed; it should be passed through the tear punctum and canaliculus in the same manner as the director, and will cut its way out as it goes.

The patient must be seen at intervals of two or three days for a week, or longer, after the operation, and a probe passed along the incision to prevent its closing.

Probing the nasal duct.—For the treatment of stricture of the nasal duct a set of silver probes (Bowman's) are used: there are three probes in a set, the two extremities of each being of different thicknesses, so that there are six sizes, No. 1 being the smallest, No. 6 the largest. The best form are those with bulbous conical ends, fig. 37, the original ones were straight, with slightly pointed extremities.

To pass a probe down the nasal duct, the canaliculus should be first slit, or, what is better, should have been slit at some previous time. The surgeon should stand behind the patient in the same position as for performing the last operation; and the lids being made tense in the same manner, the probe should be passed along the slit canaliculus until the point is well within the sac, as shown by the absence of puckering at the inner canthus on relaxation of the tension of the lids; the opposite extremity should then be raised along the margin of the orbit until the probe has attained a vertical direction, care being taken, while so doing, to keep the end which is in the sac pressed firmly against its inner side; the probe, having been brought into a nearly vertical position, should be pushed gently but firmly downwards and slightly backwards and outwards in the direction of the duct; when it has been passed as far as it will go it should be slightly withdrawn, so as to raise its end off the floor of the nose. If the probe has been properly passed down the duct its upper part will remain firmly in contact with the margin of the orbit; but if it moves freely about, the probe is not in the duct, but has been forced through its wall. This little accident is of no particular moment, and needs

only that the probe be withdrawn and passed afresh in the right direction.

If the end of the probe is not well within the sac before an attempt is made to pass it down the duct, it may slip backwards into the orbit, or forwards and downwards in the cellular tissue of the cheek. A probe having been satisfactorily passed, should be left in for about twenty minutes; the operation should be repeated about twice a week. The treatment of stricture of the lachrymal duct is, on the whole, unsatisfactory, probing causes much pain, and it is not certain to my mind that the remedy is not worse than the disease. It is well always to commence with the largest probe (No. 6), and try a smaller one if this cannot be passed.

Washing out the lachrymal sac.—For washing out the lachrymal sac a good syringe fitted with nozzles of different sizes is required. One of the nozzles should be fitted to the syringe, which has been previously filled with fluid (water, boracic lotion, a weak solution of nitrate of silver, chloride of zinc, &c.), the nozzle should then be passed along the previously slit canaliculus into the sac and the fluid injected; the patient's head must be bent forwards during the injection, or the fluid will run back along the floor of the nose into the pharynx.

Obliteration of the lachrymal sac.—In some cases of obstinate discharge from the sac, especially if dependent on diseased bone, the discharge may be stopped, and the patient made more comfortable by closing up the sac entirely; of course, more or less watering of the eye will remain after the operation, but is far to be preferred to the annoyance of a constant purulent discharge.

Obliteration of the sac may be attempted in any of the three following ways. A free incision having been

made into it, and the blood carefully sponged out, its lining membrane may be destroyed—(1) by filling its cavity with a thick paste of chloride of zinc and starch, in equal parts, enclosed in a small piece of lint; (2) by the application of nitrate of silver, or (3) by the galvanic or other cautery. By any of these procedures adhesive inflammation is set up, more or less obliteration of the sac following.

Operations for obliteration of the lachrymal sac are by no means always successful, and may have to be repeated, perhaps more than once, before a satisfactory result is obtained.

The Conjunctiva.

But few operations are performed on the conjunctiva alone, it is of course cut in some of the operations on the eyelids and in that for strabismus, and some others.

Warts are occasionally found on some part of the membrane; they require to be removed with scissors.

Pterygium is a peculiar, somewhat triangular growth, the base of which is situated in the ocular conjunctiva generally near the inner canthus, the apex encroaching more or less upon the margin of the cornea, or passing for a considerable distance upon its surface. The growth is of a reddish colour and variable density; it consists of hypertrophied connective tissue.

Pterygium is not common in this country, and when met with is usually found to occur in sailors and others who have been in the East. Should it give rise to any inconvenience or threaten to impair vision it must be removed by operation.

The patient should lie on the couch, the lids be opened by a wire speculum, the growth seized with toothed

forceps and with a cataract knife dissected up from the surface of the cornea. An incision should then be made in the conjunctiva parallel with the margin of the cornea, and the apex of the growth fixed by a suture in the wound. The eye should be kept bound up for a few days with wet lint and a bandage.

If a pterygium is simply cut off it will, in all probability, grow again, but if transplanted it will shrivel up, and disappear without giving further trouble. A cicatrix always remains upon the cornea after removal of pterygium, so that it must never be allowed to grow over the pupil.

Pinguiculæ are small yellowish growths situated beneath the conjunctiva, generally near the outer and inner margins of the cornea; they are surrounded by a few large blood-vessels, and are occasionally the source of constant irritation, causing the eyes to be blood-shot and uncomfortable. Pinguicula can be removed, if desired, by making an incision over it, turning back the conjunctiva, then seizing the little growth with forceps, and dissecting it away from the parts beneath. The growth having been removed, the conjunctiva should be closed over the wound by a suture, and the eye kept bandaged for two or three days after the operation.

Lipoma is met with as a tumour projecting beneath the upper lid, near the fornix, and often between the superior and external recti muscles; it somewhat resembles a third lid. It is congenital. If the tumour gives any trouble it must be removed by operation, thus:—The patient lying on the couch, the lids should be kept as widely open as possible by a wire speculum, an incision made with a cataract knife through the conjunctiva over the tumour, and its most projecting portion seized with toothed forceps and removed with scissors; care must be taken not to drag upon the growth, as it is continuous with

the fat in the cavity of the orbit, a great portion of which might be pulled out. As much of the tumour as is thought necessary having been removed, the conjunctiva should be closed over it with sutures, and the eye bound up.

Naevus occasionally occurs in the conjunctiva; it may be removed by the knife, or destroyed by the galvanic or other cautery, in the latter case due precautions must be taken to guard the eyeball from injury during the operation, and to prevent as much as possible the evils arising from subsequent cicatrisation.

Pigmented growths are occasionally met with in the conjunctiva, generally near the corneal margin; they are light brown in colour and flattened, causing but little or no thickening, they can be easily removed with a knife or scissors.

Cancerous ulcers may also be met with; they must be thoroughly extirpated, the eyeball being excised, if necessary.

Cysts containing a clear serous fluid are occasionally met with in the conjunctiva; they must be punctured, when they at once subside, but sometimes re-form, in which case a portion of the cyst-wall must be excised, or a fine seton passed through it.

Cysticercus is occasionally met with in the conjunctiva as a bluish pelucid cyst, generally situated in the fold between the eyeball and lower lid, and should be treated by incision of the cyst.

CHAPTER III.

External Muscles of the Eyeball.

Strabismus (squint).—"Strabismus is a deviation in direction of the axes of the two eyeballs, in consequence of which the two yellow spots receive images from different objects. In convergent strabismus the two visual lines do not cross each other at the point it is desired to observe; only one of the two, that of the undeviating eye, reaches it. Under this deviation not only does the expression of the face suffer from want of symmetry in its most eloquent parts, but the power of vision, at least in one of the eyes, is usually disturbed, and the squinter always looses the advantage of binocular vision." (Donders).

Strabismus must not be looked upon as a special form of disease; it is in by far the greater number of cases associated with some anomaly of refraction of which it is only a symptom; other conditions which may induce strabismus will be subsequently considered.

Two forms of squint are commonly met with. 1. Convergent. 2. Divergent. Other rare forms are superior and inferior strabismus; these will receive no further notice.

Convergent strabismus is the most common of all, and is almost always the result of hypermetropia.

Divergent strabismus is frequently the result of myopia.

Convergent strabismus, as just stated, is nearly always the result of hypermetropia. It may be congenital but most commonly makes its first appearance

soon after birth or within the first two or three years of life. Squint may disappear spontaneously, consequently the parents are often told that the child will "grow out of it," no greater mistake can be made as it is much more likely to grow into it. It is attributed to a variety of causes, such as teething, injury, worms, convulsions, habit, trick, nervousness, copying, etc., none of which, however, can produce it unless hypermetropia is present. It is due to the association between *the action of accommodation and convergence* (see p. 49).

The hypermetropic individual must always accommodate when looking at even a distant object; and as the object is brought nearer, the tension of accommodation must be correspondingly increased. Now, the greater the degree of convergence the more strongly is the accommodation brought into play; consequently there is an ever increasing tendency on the part of the hypermetropic individual to converge too much, in order to bring his accommodation into the highest possible state of tension. If the visual lines converge to a point nearer the eyes than the object looked at, convergent strabismus at once results, and no doubt double images appear which the patients are too young to notice; very soon, however, one eye comes more into use than the other, and its visual line is habitually directed to the object looked at, whilst that of its fellow is directed to a point nearer the eyes "habitual squint." Or the visual lines may be alternately directed to the object "alternating squint." We speak of the eye, the visual line of which is properly directed as the "fixing eye," of that of which the visual line is improperly directed as the "deviating eye." In some cases the deviation is not always present, but only occasional, when it is called "periodic squint."

The question next arises, Why do not all hypermetro-

pic individuals squint? The reason is that if both eyes are of the same refraction, and have equal acuteness of sight, there is always such a desire to maintain binocular vision that the visual lines will remain directed to the same point, even though the eyes are not accurately accommodated for that point, the individual being content with ill-defined retinal images rather than sacrifice binocular vision by increasing his convergence.

But if vision of one eye is less acute than that of the other, or if there is a difference of refraction between the two, the desire for binocular vision is lost, or its value very much lessened, and the necessity for a well-defined image on one retina is immediately felt. The accommodation is put fully on the stretch, and with it the degree of convergence becomes excessive.

Ordinary convergent or "concomitant" squint has to be distinguished from squint the result of paralysis, "paralytic" squint. This can be done by noticing the relation of the convergence of the eye which is observed to be squinting—"primary" squint—to the deviation—"secondary" squint—which occurs in the properly directed eye when it is covered and an attempt made to fix an object with the squinting eye. In concomitant squint the primary and "secondary" deviations are equal; in paralytic squint the "secondary" deviation is greater than the "primary."

Treatment.—Slight cases of convergent strabismus, especially if the deviation is not constantly present, but only occasional (periodic squint), may be cured by the constant use of glasses which accurately neutralise the existing hypermetropia.

In more severe cases division of the internal rectus tendon in one or both eyes is necessary; but in no case should tenotomy be performed before the age of seven years. Glasses should be ordered as soon as the child

is old enough to wear them, and should be worn constantly. We often meet with cases in which the visual lines remain properly directed as long as the glasses are worn, but squint immediately occurs when they are removed. In such the necessity for wearing glasses for distance may be obviated by tenotomy, and if the patient wishes to go about without them the operation should be performed; if, on the contrary, he is content to wear his glasses constantly, no operation is requisite.

It is often difficult to decide whether only one or both eyes should be operated on.

If it is found than one eye squints habitually and to no great extent, the other being always used for fixing an object, division of the internal rectus of that eye which habitually deviates alone is necessary.

If each eye deviates alternately (alternating strabismus), and to no great extent, division of one internal rectus may be sufficient; but if three weeks or a month after the operation the squint still continues, tenotomy of the internal rectus of the other eye should be performed.

If one eye squints considerably and habitually, or if the deviation, though alternating, is excessive, the internal rectus in both eyes must be divided. In any case, if there be a doubt as to whether one or both eyes should be operated on, it is well to be on the safe side, and do only one at a time.

Operations for convergent strabismus.—There are two principal methods of operating for convergent strabismus.

1. The operator should stand on the right side of the patient, placed in the usual position (fig. 32, p. 204), and the eyelids being kept well open with a wire-speculum, should seize the conjunctiva and subconjunctival fascia with the toothed forceps (fig. 38) at a point about mid-

way between the margin of the cornea and semilunar fold, and just below the inferior margin of the tendon of the internal rectus muscle. An incision should then be made with strabismus scissors (fig. 40) through the conjunctiva and subconjunctival fascia, well down to the sclerotic, and the strabismus hook (fig. 39) passed

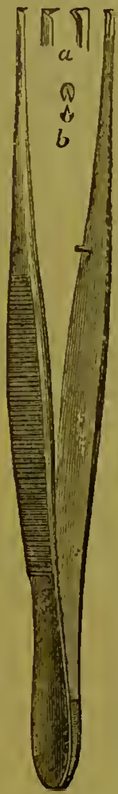

Fig. 39.—Strabismus hook.

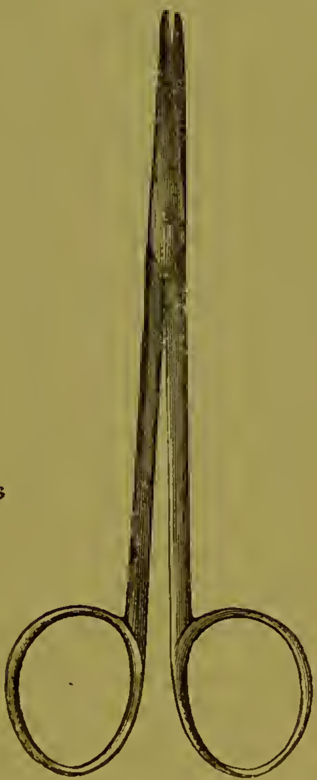

Fig. 40.—Strabismus scissors.

Fig. 38.—Toothed and fixing forceps. *a*, their points shown in side view; *b*, front view.

through the opening and inserted between the tendon and the eyeball. If properly introduced the hook will be brought up short at the insertion of the tendon into the sclerotic when it is pulled forwards; it should be held firmly in position, the scissors passed through the

opening, one blade following the hook between the tendon and the eyeball, the other being kept outside the tendon, which is thus included between the two blades, and the tendon should then be divided by one or two sharp strokes with the scissors.

The scissors may now be withdrawn, and the hook pulled forwards; if the latter meets with no resistance, but passes freely up to the corneal margin, the operation has been successfully performed; to make sure of this, however, the hook should be withdrawn, the action for hooking the tendon repeated, and any fibres that may have escaped division cut through.

On the division of the tendon the muscle retracts, the retraction being limited by the subconjunctival fascia with which it is intimately connected. If the eye is not properly directed after simple division of the tendon, a greater effect may be produced by further freely severing the subconjunctival fascia.

2. In the second operation, the position of the patient and surgeon should be the same, and the lids be kept open with the wire speculum, as in the one already described.

An incision should be made with scissors through conjunctiva and subconjunctival fascia, over the insertion of the tendon, instead of below its inferior margin; the tendon then picked up with the strabismus hook, and divided close to the sclerotic. The wound in the conjunctiva should be afterwards closed with a fine suture. Both these operations may be performed from above instead of below, at discretion of the operator.

No after-treatment is required for strabismus operations; the patient may go about as usual and simply keep the eyes clean. But if, when the eyes have quite recovered from the effects of the operation, there should

be any return of the squint manifested, the degree of hypermetropia must be carefully ascertained, and glasses which thoroughly neutralise it ordered to be used for all purposes. In most cases this will be found sufficient; but if, after the glasses have been perseveringly worn for some weeks, no effect is produced the operation should be repeated in one or both eyes; or if tenotomy has only been performed in one, the other should be operated on.

Use of anæsthetics in operations for convergent strabismus.—Whether anæsthetics should be employed or not in squint operations appears to be a matter of opinion; some eminent oculists never employing them, others again rarely operating without. For my own part, I prefer to use an anæsthetic, but taking care, however, that a full effect is not produced, and if there is any doubt as to whether one or both eyes are to be operated on I allow the patient to come nearly to after finishing one eye, so as to ascertain the effect produced by what has been done; if an anæsthetic is given to such an extent as to exert its fullest influence, and produce thorough muscular relaxation, an erroneous idea of the effect of the operation is likely to be formed, and on the return of consciousness the squint may remain as bad as ever. Cocaine deadens but does not entirely remove the pain of a tenotomy; a few drops should be injected beneath the conjunctiva—after it has become anæsthetic —just over the insertion of the tendon.

Other conditions than hypermetropia which may produce convergent strabismus are :—

1. Disease of the brain.
2. Paralysis of the external rectus muscle.
3. Inflammatory or other changes in the internal rectus muscle itself, resulting in shortening.

In the first two of these no operation is advisable, the

third may sometimes be remedied by operative interference.

Divergent strabismus, as already stated, is often the result of myopia; it is usually consequent on high degrees of the anomaly, and is brought about as follows:—The highly myopic individual requires to bring objects very near the eyes to see them distinctly, consequently a very high degree of convergence is necessary to keep both visual lines directed to the same point; now, not only has a high degree of convergence to be maintained, but in myopia the length of the eyeball, and the consequent impairment of its mobility place the internal recti at a disadvantage. Moreover, in order to direct the visual lines of the myopic eyes to the same point, a greater proportionate amount of convergence is required than in emmetropia.

As a consequence, the internal rectus of one eye sooner or later becomes wearied and gives in, and the eye deviates outwards, binocular vision being sacrificed.

Treatment.—Many cases of divergent strabismus may be remedied by the use of concave glasses, which enable the individual to see distinctly at a distance up to which convergence of the visual lines can be maintained without undue strain of the internal recti muscles.

If in spite of the use of glasses the divergence continues, it must be remedied by operation. In cases where the eye only deviates outwards, after an object has been looked at for some considerable time, subconjunctival division of the external rectus of the deviating eye or of both may suffice for a cure; but in cases where one or both eyes diverge constantly, and the visual lines can only be made to meet in one point by a great effort, or not at all, the operation of "readjustment" must be performed.

This operation can be performed as follows:—The patient being placed in the usual position (fig. 32, p. 204) and thoroughly anæsthetised, the operator should stand behind, fix the lids open with a wire speculum, with strabismus scissors make an incision through the conjunctiva and subconjunctival fascia, below the insertion of the external rectus; hook up the tendon, and divide it subconjunctivally close to the sclerotic.

An incision should then be made through conjunctiva and subconjunctival fascia, about midway between the insertion of the internal rectus and inner margin of the cornea, of such a length as to reach about two lines above and a like distance below the margins of its tendon, which should then be hooked up and divided. The muscle and subconjunctival fascia should be freely separated from the parts beneath, and together with the conjunctiva turned back towards the caruncle. Two curved needles holding fine silk sutures should then be passed through the tissues next the margin of the cornea, and the sutures firmly tied, two free ends being left; the needles should then be carried from within outwards, through the muscle, subconjunctival fascia, and conjunctiva, as near the inner canthus as possible, and the silk drawn through; a considerable portion of the muscle and other tissues should then be removed with scissors, the free ends of the two sutures and the portions to which the needles are still attached then tied firmly together (the eye being rolled well inwards by an assistant as the knots are pulled tight), and the ends of the silk cut off close.

The eye should be bound up with wet lint and a bandage. The sutures will probably require removal in about four or five days, but may be left longer, if they cause no irritation.

Divergent strabismus is met with in cases of paralysis

of the third nerve, it may also occur in non-hypermetropic eyes if the sight of one has become much impaired, and binocular vision no longer possible, and may be caused by too free a division of the tissues in the operation for convergent squint. In the first of these cases no operation is advisable, in the second, no improvement of sight is to expected from re-adjustment, but the operation may be performed simply to remedy disfigurement. In the third, re-adjustment should be performed.

CHAPTER IV.

The Cornea, Sclerotic, and Iris.

The affections of the cornea which require an operation upon the structure itself are six:—1. Sloughing ulcer. 2. Conical cornea. 3. Corneal opacity. 4. Staphyloma. 5. Lodgment of foreign bodies. 6. New growths.

Paracentesis, or tapping the anterior chamber.—This operation is sometimes performed in cases of sloughing ulcer, or suppuration, threatening perforation. By the timely evacuation of the contents of the aqueous chamber, a large rupture of the corneal tissue, with its accompanying evils, may in many cases be avoided.

Tapping the anterior chamber may be done thus:—The patient being in the usual position (fig. 32, p. 204), and the eye under the influence of cocaine, the operator should stand behind, and fix the lids open by a wire speculum or by the fingers; a broad needle should then be passed through the cornea at some convenient part of its margin. When the point of the needle has fairly entered the anterior chamber, its handle should be rotated, so as to bring the breadth of the blade across the incision and thus open it; as soon as the contents of the anterior chamber have flowed out, the needle should be withdrawn, a drop of eserine solution placed between the lids, and the eye bound up in the usual manner. The eserine is used to contract the pupil, and so make the iris tense, and prevent its prolapsing into the wound made by the needle.

Iridectomy, in such cases, however, is to be preferred to paracentesis.

Conical cornea (staphyloma corneæ pellucidum), as the name implies, signifies an alteration in the curvature of the cornea, of such a nature that it assumes the form of a cone. The origin of the affection cannot clearly be traced.

The most prominent symptom is gradually increasing myopia, which cannot be remedied by concave lenses. On looking at the cornea in profile, its conical form is very evident; but when seen from the front its centre appears as if occupied by a drop of water.

On examination with the ophthalmoscope, by the direct method, the apex of the cone which may, however, be the seat of some opacity, appears brightly illuminated; around this bright portion is a dark ring, which changes its position as the light is thrown from different points, corresponding to the sides of the cone, this being again succeeded by an area giving a bright reflection, and corresponding to a portion of the cornea which retains more less its normal curvature.

Objects occupying the fundus of the eye are seen through the apex and sides of the cone near its base, in an inverted position, as in myopia, whilst we obtain a more or less distinct erect image of the same parts; through that portion of cornea which still retains its normal curvature. The retinal vessels appear to have a whirl-like motion as we change our point of view from side to side. This appearance is quite characteristic, and once seen is not likely to be forgotten.

Treatment.—Conical cornea can only be remedied by operative interference; two methods of operating are practised, the object of each being to flatten the cone, and restore to the cornea its natural curvature.

In one operation an elliptical portion including the

whole thickness of the cornea is removed from the apex of the cone. The operation can be performed thus (for the position of patient and operator *see* fig 32, p. 204):—Cocaine may be used or an anæsthetic given, the lids should be held open by a wire speculum, and the eyeball fixed by seizing with the toothed forceps, the conjunctiva and sub-conjunctival fascia, at some point near the corneal margin. A straight cataract extraction knife (fig. 47*c*) should then be thrust through the cone from side to side, a small flap formed by cutting out either upwards or downwards, and the flap so made seized with iris forceps and removed with scissors.

In this operation the anterior chamber is opened, and the cornea collapses as soon as the first incision is made. Care must be taken that the portion removed includes the most prominent part of the cone, and that the opening left is exactly opposite the pupil.

After the operation, the speculum must be very carefully removed, the lids gently closed, both eyes secured by strapping and bandaged in the usual way; the eye must on no account be opened for a fortnight, by which time the opening in the cornea should have filled up and the anterior chamber been restored. If healing has taken place, the sound eye may be left uncovered except by a shade, but if the wound has not closed, both eyes should be kept bandaged until it has firmly healed.

The margin of the pupil is not unfrequently caught up in the incision, an anterior synechia resulting.

The operation described gives the most satisfactory results, the curvature of the cornea being greatly improved, and a corresponding amount of vision regained.

In the second operation, a superficial portion only is removed from the apex of the cone with a small trephine, a raw surface being left, which by its subsequent

cicatrisation and contraction causes considerable flattening of the cone. Or a cicatrix may be formed by using instead of the trephine, a small pointed galvanic or other cautery; the whole apex of the cone should be seared and a small perforation made in its centre. Whichever method is used cocaine is the only anæsthetic required. In the first of these two methods only the eye that has been operated on need be bandaged; in the second both should be tied up till the anterior chamber has reformed.

Tinting the cornea is called for in cases of dense white opacity (leucoma), causing disfigurement. The operation can be performed as follows:—

For position of patient and operator see fig. 32. p. 204. Cocaine having been applied the operator should place the wire speculum between the lids, fix the globe with the toothed forceps, paint some Indian ink upon the opacity, and prick it thoroughly in with a bunch of needles fixed in a handle; the ink should be sponged away from time to time in order to allow the operator to see what progress he has made.

The opacity having been thoroughly tinted, the speculum should be removed, no bandage need be applied, and no after-treatment is necessary, very little irritation follows. If after the lapse of a week or ten days the opacity does not appear sufficiently blackened, the operation may be repeated.

If the ink is allowed to get into the wound made in the conjunctiva by the toothed forceps, a black mark will be left; care should therefore be taken to fix the globe at a point to which the ink cannot run. Should the anterior chamber be opened, the operation must be discontinued, as the lens may be wounded.

Staphyloma, first so called from its supposed resemblance to a grape, has now come to mean a bulge on

any part of the eyeball. On the cornea it is caused either by yielding of its structure, or more commonly by prolapse of iris through a perforation in it, the prolapsed portion being firmly coated over with inflammatory material. Staphyloma is said to be "total" where the whole of the cornea is affected, "partial" when some portion of it retains its normal curvature. Total staphyloma should be removed by abscission evisceration performed, or the eyeball excised. Partial staphyloma may subside on the performance of iridectomy, or can be removed as follows:—The position of patient and operator should be as at fig. 32, p. 204, and cocaine applied or an anæsthetic administered. The lids being kept open by the wire speculum, a curved needle armed with fine silk should be passed through the base of the staphyloma, an elliptical portion of which should then be removed with a straight cataract knife, the silk should then be drawn through and tied, thus bringing the edges of the gap made by the removal of the elliptical portion together, and the eye bandaged in the usual way. The suture may be removed in the course of three or four days.

Foreign bodies.—Small fragments of metal, chips of stone, thorns, etc., are not unfrequently found lodged in the cornea. To remove them, the position of patient and operator should be as fig. 31, p. 204. Cocaine having been applied, the lids should be kept open by the fore and ring fingers of one hand, and the globe steadied by gently pressing upon it with the second finger, the foreign body should then be carefully lifted from its bed with the point of a knife or small spud held lightly in the other hand. Foreign bodies especially thorns, are sometimes so firmly and deeply embedded, that they require to be cut out. In such cases it is best to administer an anæsthetic, and a moderately broad

bladed knife should be passed through the cornea so as to go behind the foreign body and prevent its dropping into the anterior chamber.

New growths may be met with springing from the cornea.

Congenital tumour is a small white flattened elevation usually situated near the corneal margin, encroaching on both cornea and sclerotic; it lies beneath the corneal epithelium and conjunctiva, and appears to extend pretty deeply into both cornea and sclerotic; the growth is present at birth, but usually increases somewhat as the child grows up. It may give rise to astigmatism by causing distortion of the cornea.

The growth may be single or there may be two or tnree little tumours. Their structure is that of connective tissue, and occasionally small hairs grow upon them.

Should the little growths give rise to inconvenience, they can be shaved off level with the cornea, but as a rule they cannot be entirely removed.

Round and spindle-celled sarcomata have also been met with growing from the cornea. Such cases usually call for extirpation of the eyeball.

The Sclerotic.

Sclerotomy as already stated is one of the operations for the treatment of glaucoma. In performing the operation, the position of operator and patient should be as in fig. 32, p. 204. The instruments required are a straight cataract knife (Fig. 47*c*) speculum, and fixing forceps. An anæsthetic should be given. The lids should be held open with the speculum, the eyeball fixed with the forceps. The knife should be entered on the

outer side of the globe as far back in the sclerotic as is consistent with entering the anterior chamber quite at its periphery, pushed across the chamber, and brought out at a corresponding point on the inner side. The transfixion having been finished, the incisions should be enlarged to about double the width of the knife blade, which should then be withdrawn, its point being carried round the margin of the anterior chamber so as to notch the parts bounding it, but not cut through the sclerotic. The division of the sclerotic may be made either upwards or downwards; the points of puncture and counter puncture being situated midway between the horizontal meridian of the cornea and its upper margin in the former case, midway between its horizontal meridian and lower margin in the latter.

The Iris.

Iridectomy or excision of a portion of the iris is an operation which has a very wide range of usefulness and is very frequently required. It is called for in all cases in which it is desirable to influence the tension or nutrition of the eyeball; it is a part of the operation for extraction of cataract by the small flap or linear methods, in a somewhat modified form is one of the methods of making an artificial pupil, and is useful in some other cases.

Iridectomy is performed (1) to influence tension.

(*a*) In sloughing ulcers, or suppuration of the cornea, accompanied by pain, and threatening perforation, the tension being increased or not. In such cases iridectomy gives almost instant relief to the most severe pain, and will in all probability save the cornea from rupture.

(*b*) In injuries of the eyeball in which the lens being wounded, has become opaque and swollen, and is pressing on surrounding parts, causing severe pain and increase of tension, and thus threatening the integrity of some of the delicate structures of the globe. In such cases, not only does iridectomy diminish tension and

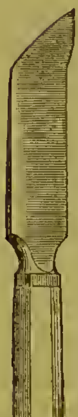

Fig. 41. Bent iridectomy knife.

Fig. 42. Iris forceps.

Fig. 43. Iris scissors.

Fig. 44. Iris hook.

relieve pain, but also gives room for any further swelling of the lens.

(*c*) In staphyloma of the cornea iridectomy often causes complete subsidence of the projection.

(*d*) In glaucoma a timely and well-performed iridectomy causes instant and lasting diminution of tension and places the eye in comparative safety ; the operation

should be performed on any eye that can distinguish *bright* light, and to relieve pain in any case whether there be perception of light or not; in acute glaucoma it must be tried even if all perception has been lost for some days.

(2) To influence nutrition, iridectomy should be performed in chronic choroido-iritis, recurrent iritis, and in cases of exclusion of the pupil, where there is no communication between the anterior and posterior divisions of the aqueous chamber.

(3) Associated with operations for cataract, iridectomy should be performed previous to a needle operation if much swelling of the lens be anticipated; or it may require to be done after the needle has been used if pain or increase of tension occur.

The operation should also be performed at some time previous to, or simultaneously with, small flap or linear extraction of cataract.

(4) Iridectomy for artificial pupil is mentioned at another page.

(5) Other conditions in which iridectomy may be required are:—

(*a*) Hæmorrhage into the vitreous humour.

(*b*) Displacement of the retina.

(*c*) As an aid to the removal of foreign bodies from the globe.

(*d*) Some peculiar conditions of intra-ocular circulation.

Operation of Iridectomy.

Instruments.—A wire speculum (Fig. 35), a straight or bent iridectomy knife (Fig. 41), a pair of toothed forceps (Fig. 38), a pair of iris forceps (Fig. 42), iris scis-

sors (Fig. 43) and a curette (Fig. 47*a*). For the position of patient and surgeon see fig. 32, p. 204. The patient should be brought fully under the influence of an anæsthetic, the lids kept widely open by the wire speculum, and the eyeball fixed by seizing the conjunctiva and subconjunctival fascia near the corneal margin with the toothed forceps; then, with a straight or bent iridectomy knife of medium size, an incision should be made in the sclerotic, in such a position that the knife enters the anterior chamber quite at its peripheral part, and close to the anterior surface of the iris.

The knife, having entered the anterior chamber, should be pushed steadily on (care being taken to keep its point well forwards towards the cornea, so as not to wound the lens) until the point is opposite the centre of the pupil. The point should then be turned to one side, so as to be out of the pupillary area, and the knife slowly and gently withdrawn, the hold of the forceps being let go at the same time. The incision thus made should be of such a length as to correspond to about one-fourth of the circumference of the iris.

The next step in the operation is the removal of a portion of the iris. If, as is not unfrequently the case, the iris has become prolapsed, it needs only to be seized with the forceps, and a piece of the desired size removed with the scissors. If the iris does not protrude, the iris forceps should be introduced, shut, through the wound in the sclerotic, and pushed on until the extremities of their blades are opposite the nearest portion of the pupillary margin; they should then be allowed to open of themselves, when the iris will be pushed between the blades by the pressure of the parts behind; no backward pressure must be made with the forceps, but they should be gently closed and withdrawn, carrying the iris with them, which should then be cut across with the

scissors, close to one angle of the wound, drawn over to the other angle, and a piece cut off; the curette should be passed between the lips of the wound so as to push back any portions of iris that may have become entangled in it. The eye should then be bound up with lint and a bandage. The form of the pupil after a well-performed iridectomy should resemble Fig. 46 D.

With regard to the position of the portion of the iris to be removed, opinions are at variance. If the surgeon be a skilful and experienced operator, and has the aid of a competent assistant, the iridectomy should be done upwards, so as to place the gap beneath the upper lid, and thus conceal it as much as possible.

To perform iridectomy upwards, a bent iridectomy knife should be used, and the incision made in the sclerotic above the upper margin of the cornea, an assistant should then draw the eyeball downwards with forceps, the iris forceps should be inserted, and the portion of iris removed as previously directed.

An inexperienced operator will find it much easier to remove the portion of iris from its outer and lower segment. In this case a straight iridectomy knife can be used, and no assistant is required. The result is rather an ugly gap, the disadvantage of which, however, is quite counterbalanced by the ease and safety with which the operation can be performed.

Accidents which may happen during the operation of iridectomy, and difficulties which may be encountered.—The accidents which may occur are:—

(1) Wound of the lens from insufficient care in keeping the point of the knife well forward. This accident will, in all probability be followed by the formation of traumatic cataract.

(2) Escape of vitreous humour, is very likely to occur in hard eyes, if the knife be too quickly withdrawn, or

if undue pressure be exerted on the globe with the fixing forceps.

(3) The iris may be torn away from its insertion at a point opposite to the incision, if undue traction be exercised upon it with the iris forceps.

Difficulties.—The iris may be found so rigid that it cannot be seized with the forceps, or so rotten that only very small portions can be brought away; sometimes it bleeds profusely when touched, filling the anterior chamber with blood, and considerably hindering the operation.

Artificial pupil.—The operation for artificial pupil is performed to open a new path for rays of light to the retina, the natural passage being obstructed.

It is indicated in the following cases:—(1) In central opacity of the cornea, with or without anterior synechiæ. (2) In closure of the pupil. (3) In central opacity of the lens or its capsule.

The artificial pupil must be small, as nearly central and as well defined as possible. Care must be taken to make it behind that portion of the cornea which is most transparent and least altered in curvature, the best situation being ascertained by oblique illumination. The new pupil must not be made directly upwards, or it will be covered by the upper lid.

An artificial pupil can be made in any of the following ways:—(1) By incision of the iris. (2) By tearing it away from its insertion. (3) By excision of a portion (iridectomy for artificial pupil).

In operations for artificial pupil the position of patient and surgeon should be the same as in "iridectomy," and an anæsthetic should be administered.

1. *(a) Incision.*—This operation is called for in cases of complete closure of the pupil, following removal of the lens, either by operation or injury, but is not advis-

able unless the lens is absent. In these cases the iris may be found changed into a tense, unyielding membrane, which cannot be seized with forceps.

The operation of "incision" may be performed either by thrusting a straight cataract knife through the cornea near its margin, and then incising the iris, so as to cut across its radial fibres, or an incision having been made with an iridectomy knife in the sclero-corneal margin, a pair of Wecker's scissors, fig. 45, (having one sharp and one blunt-pointed blade) may be introduced through the wound, one blade being thrust through the iris at its nearest point and passed behind it, the other carried along its anterior surface, and the iris then cut fairly across from one side to the other.

Whichever plan of incision is adopted, the vitreous

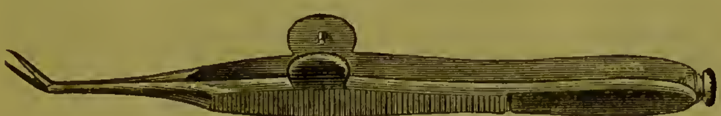

FIG 45.—Wecker's scissors. (*From* Bryant).

humour pushes forward into the wound, and keeps its edges widely separated, a pupil resembling fig. 46 A being formed.

There are two other methods of making an artificial pupil by "incision" known as single and double "iridotomy."

For the positions of patient and surgeon in performing either of these operations, see fig. 32, p. 204.

(b) Single iridotomy should be thus performed:—The eyelids being kept open with the wire speculum, and the eyeball fixed by seizing the conjunctiva and subconjunctival fascia, close to the margin of the cornea at its inner side, an incision should be made with an iridectomy knife in the cornea, about midway between its margin and the pupil, and opposite to the point of fixation with the forceps. The scissors (Wecker's, fig. 45)

must be then introduced closed through the wound into the anterior chamber, the blades opened, the blunt one passed through the pupil behind the iris, the other on its anterior surface, and the sphincter of the pupil be divided with one sharp cut. The scissors should then be withdrawn, any prolapse of iris that follows replaced with the curette, a drop of atropine placed between the lids, and the the eye lightly bandaged.

This operation is applicable in cases where the lens is present, its centre being opaque, and its peripheral portion clear.

(c) Double iridotomy is applicable in cases of closed pupil after cataract extraction. An incision should be

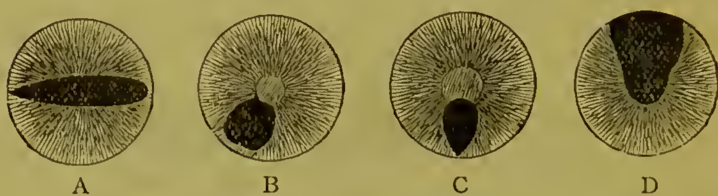

FIG. 46.—A. Pupil after incisions. B. Pupil after excision. C. Pupil made by using iris hook. D. Iridectomy for glaucoma, &c. (*From* Bryant).

made with an iridectomy knife through the upper part of the cornea, the knife carried through the iris and along its posterior surface so as to make a fair sized wound in it; the incision being finished, the knife should be carefully withdrawn, and, very possibly, some vitreous humour will follow it.

The next step in the operation is to pass Wecher's scissors, closed, through the wound in the cornea into the anterior chamber, open them, pass one blade behind the iris, the other in front of it, make an incision in a direction downwards and inwards, then change the direction of the scissor blades and make a cut downwards and outwards. Thus a small piece of iris is en-

closed by a V-shaped incision, the apex of the V being upwards. The small portion of iris contracts up, and a somewhat triangular pupil is left. The eye should be bound up as usual.

(2) **Tearing away the iris from its insertion (Iridodyalisis).**—An incision having been made through the cornea on the side opposite to that on which the iris is to be removed, a pair of iris forceps should be passed through the wound, and across the anterior chamber, the iris seized close to its greater circumference, and torn away from its insertion; the instrument should then be carefully withdrawn and the eye bound up. If necessary, the whole iris may be removed in this way. This operation is applicable in cases of dense central corneal opacity (leucoma), in which some transparent cornea is left at the margin.

(3) **Excision—Iridectomy for artificial pupil.**—An incision should be made of the requisite size, through some part of the sclero-corneal margin, the iris forceps introduced through the wound, the ends of their branches passed fairly up to the margin of the pupil, the iris seized and drawn out through the wound, and a small portion removed with scissors. The curette should then be passed between the lips of the wound so as to push back any portion of iris that may have become entangled in it; a pupil resembling fig. 46 B should be formed.

Instead of the iris forceps an iris hook (fig. 44) may be used to withdraw the iris from the anterior chamber. A very small incision having been made in the cornea, just within the sclero-corneal junction, the iris hook should be introduced so that the hook lies flat on the surface of the iris; it should be pushed on until the end of the hook is opposite the nearest margin of the pupil, the point of the hook then turned downwards

so as to catch the pupillary margin and gently withdrawn carrying the iris with it; when the hook is about to emerge from the wound, it must be rotated so as to turn its loop parallel to the lips of the incision. As soon as the hook has been brought outside the wound, it must be held quite steady, and the piece of iris it carries cut off by a snip of the iris scissors. The curette should then be passed between the lips of the wound to push back the iris which may be engaged in th e eye should then be bandaged in the usual way If the operation has been properly conducted, a pupil resembling fig. 46 C will be the result.

CHAPTER V.

THE CRYSTALLINE LENS.

CATARACT.

By cataract we understand an opacity of the crystalline lens.

The causes of this opacity are somewhat obscure, but it probably depends on impairment of nutrition of the lens consequent on senile decay or constitutional conditions, (*e.g.*, diabetes).

Cataract also occurs in connection with inflammatory changes in adjacent parts—the choroid, ciliary body, vitreous, and iris—when it is called secondary cataract; it is met with as a congenital defect, and very frequently results from injury—traumatic cataract.

FORMS OF CATARACT.

There are two principal forms of cataract.

(1) *The cortical or soft cataract.*

(2) *The nuclear or hard cataract.*

In the first form the cortical substance of the lens is primarily affected, the nucleus afterwards becoming opaque, the whole being soft, or even fluid.

In the second, the nucleus of the lens becomes hard, yellowish, and opaque; the cortical substance, though some opaque striæ often appear in it about the periphery of the lens, does not entirely lose its transparency until afterwards.

Cortical cataract is met with as an idiopathic disease in childhood and early adult life, and as the result of injury at all ages.

There are several varieties of cortical cataract.

(a) Zonular or lamellar cataract is either congenital or commences soon after birth; it is characterized by an opacity of circular form, situated in the cortical substance of the lens, but at some distance from its surface; the margin, nucleus, and superficial layers of the lens are transparent. Seen with the ophthalmoscope, the pupil being dilated, lamellar cataract appears as a circular more or less dense disc on a red ground. As a rule the opacity is quite well-defined, but in some cases a few spiculæ may be seen extending into the transparent portion of lens. Lamellar cataract rarely increases in area, but the opacity may become more dense as the child grows up.

Lamellar cataract is often associated with a peculiar eroded condition of the teeth, especially of the incisors, and the patients affected by it are often said to have had fits during teething. This condition of the teeth is attributed by Hutchinson to the too free use of mercurial teething powders.

(b) Ordinary congenital cataract is a bluish-white opacity of the whole lens.

(c) Traumatic cataract is an opacity of the lens often accompanied by swelling, and caused by rupture of its capsule from injury, and the subsequent action of the aqueous humour upon its substance.

(d) Posterior polar cataract, an opacity commencing at the posterior pole of the lens; and :—

(e) Entirely fluid or diffluent cataract are caused by changes in the lens, secondary to inflammation, syphilitic or otherwise, of the choroid or ciliary body, and are often associated with changes in the vitreous. Posterior polar cataract, although commencing at the posterior pole progresses slowly, and after covering its posterior surface at length attacks the anterior surface of the lens, the whole eventually becoming opaque, and a nucleus of greater or less size and density being formed.

The variety of cataract met with in diabetes is composed principally of soft material, but if the patient be advanced in years, there is usually a hard nucleus.

Nuclear cataract occurs in persons who have passed the middle period of life, and is characterized by the presence of a hard yellowish central portion or nucleus of varying size and density; the nucleus is surrounded by more or less soft cortical substance, and is occasionally of a greenish, or almost black colour, giving rise to what is known as *green* or *black cataract.*

Diagnosis of cataract.—The existence of cataract is easily ascertained by oblique illumination, the pupil having been dilated with atropine or other mydriatic previous to making the examination.

Treatment.—The treatment of cataract is entirely operative, no kind of medication being of the least use.

Our object in performing an operation is to open a path for rays of light to pass to the retina. This can be attained in one of two ways, the method adopted depending on the kind of opacity present.

(1) In cases (as lamellar cataract) where the bulk of the lens is clear, the opacity being situated in the axis of the normal pupil, very useful vision is procured by making an artificial pupil, opposite a transparent portion of the lens (*see* Fig. 46 C).

(2) When the whole lens is opaque, its entire removal must be accomplished.

Two varieties of operation are performed to secure the removal of the whole lens:—

(1) The operation for solution or absorption.

(2) Extraction.

Forms of cataract to which each operation is applicable.—As a broad rule, cataract occurring in persons below twenty is of the soft or cortical form, and should be removed by solution or extraction through

a very small flap section; cataract occurring in persons above thirty (except traumatic cataract) is of the hard or nuclear form, and must always be removed by extraction.

In the intermediate decade a doubt may arise as to what is the best plan of procedure; in these cases the surgeon must be guided by the general appearance of the cataract, if it appears bluish in colour, and somewhat swollen, it is probably soft and can be removed by solution or extraction through a small section. If there is a distinct yellow reflexion from its centre, denoting the presence of a hard nucleus, it should be removed by extraction. It must also be borne in mind that loss of time is a very serious consideration with most patients, consequently a preference must always be given to that operation which will allow them to resume their occupations as early as possible.

Solution, though perhaps somewhat safer than extraction, is always a tedious process, and the more so the older the patient, consequently preference must be given to extraction in all cases where the condition of the patient's sight is such as to prevent him following his occupation, even though there be no appearance of a hard nucleus. In cases where the cataract is evidently soft, and one eye retains useful vision, solution is to be preferred to extraction, as the patient can continue at his work during the time that absorption is going on.

Before performing any operation for cataract we must take care to ascertain that the eye has good perception of light, indicating that the retina is in a normal condition; otherwise no improvement in vision will result from removal of the lens. Before performing extraction we should also ascertain whether or no the cataract is mature. If the lens is entirely opaque, the opacity fills the pupil and is level with its margin. If it is only par-

tially opaque, the opacity will be evidently at a level posterior to the plane of the pupil, though some opaque striæ may be in front of the chief opacity. Oblique illumination causes a dark semi-circle to appear upon the opacity at the side from which the light is thrown; it is the shadow of the iris bounding that part of the margin of the pupil. If any red reflex is returned from the fundus when examined with the ophthalmoscope, the cataract is very far from ripe.

Immature cataract should if possible be left alone, but when both eyes are affected, and the patient has no useful vision, extraction in one eye—after a preliminary iridectomy—must be performed.

If cataract occur in one eye only, the other being unaffected, it is best left alone, but in young persons it may be removed as its appearance may interfere with their success in life.

Operations for Removal of Cataract.

Solution.—In the operation for solution the capsule of the lens is opened, and its substance thus allowed to be acted upon by the aqueous humour, by which it is broken up and softened, absorption finally taking place.

The operation should be performed as follows (for the positions of patient and operator see Fig. 32, p. 204):—A mixture of cocaine and atropine should be applied so as to cause anæsthesia and dilate the pupil; the operator, keeping the eyelids separated by the fore and ring fingers of one hand, and steadying the globe by pressing the second finger gently upon it, should take a cataract needle in the other hand and pass it obliquely through the cornea at such a distance from its centre that any resulting cicatrix will not interfere with vision; the needle should then be pushed on across the anterior

chamber into the area of the pupil, its point then depressed and three or four incisions made in the lens-capsule, so as to divide it freely. Care must be taken to use the needle very gently, and not to pass it too deeply into the lens, otherwise the suspensory ligament may be torn and the lens displaced.

The capsule having been freely divided, the needle should be carefully withdrawn and a drop of solution of atropine placed between the lids; the only after-treatment required is the constant use of atropine, so as to keep the pupil widely dilated.

If the eye is examined in the course of a few days white flocculent lens matter will be seen protruding through the opening in the capsule into the anterior chamber, showing that the lens is swelling and undergoing solution.

It will probably be necessary to repeat the operation in about a month or six weeks, and possibly on one or two subsequent occasions, before the whole lens is absorbed. The process of absorption will occupy five months or longer; capsular obstructions are frequently left. Care must be taken not to do too much at one sitting, or the lens will swell rapidly and press upon the surrounding parts, giving rise to severe pain, iritis, cyclitis, and secondary glaucoma.

Extraction of cataract.—The object of operations for extraction of cataract is the removal of the lens through an incision either altogether in the cornea, the sclero-corneal margin, partly in the sclerotic and partly in the cornea, or wholly in the sclerotic; the incision being either simple or associated with excision of a portion of iris.

Extraction can be performed by one of the following methods:—(1) Small flap with iridectomy, (2) by oblique corneal section, (3) linear incision, (4) by means

of a traction instrument, (5) by suction, and (6) extraction through a very small flap section. In the second method no iris is removed; in the first, third, and fourth, iridectomy should be performed either at the time of removal of the lens or some weeks or months previously. In the fifth and sixth iridectomy is not necessary unless the iris prolapses through the wound and will not remain in the anterior chamber if returned. Entirely

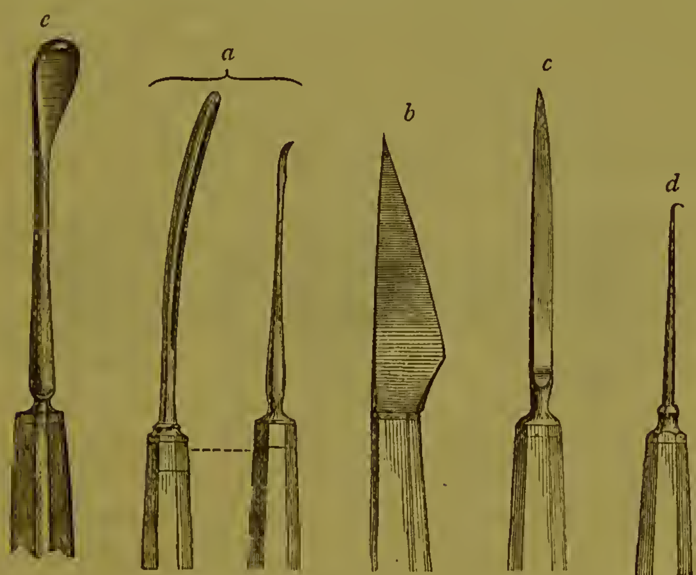

Fig. 47.—Instruments for extraction of cataract.
a. Curette and pricker. *b.* Triangular cataract knife. *c.* Straight cataract knife (Graefe's). *d.* Sharp hook. *e.* Scoop.
(*From* Bryant).

opaque lenses (mature cataracts) may be removed by the second method; all partially opaque lenses (immature cataracts) must be extracted by the first or third, We shall, however, find that in all cases whether of mature or immature cataract we obtain most uniform success by extraction associated with iridectomy; we should on no account attempt to extract an immature cataract without first excising a portion of iris, and it is

well to do so as a preliminary some weeks before the lens is removed; by so doing the risk of iritis after extraction is greatly lessened. A traction instrument should be used in any case where great difficulty is encountered, or where escape of vitreous has taken place before the lens has been extracted. The methods 5 and 6 are applicable to quite soft or fluid cataract only.

Extraction of cataract can be performed under cocaine in all patients possessing ordinary fortitude; but nervous, fidgity subjects should be brought fully under the influence of an anæsthetic. If cocaine is used as soon as the section is finished a small quantity of the solution should be introduced into the anterior chamber by pass-

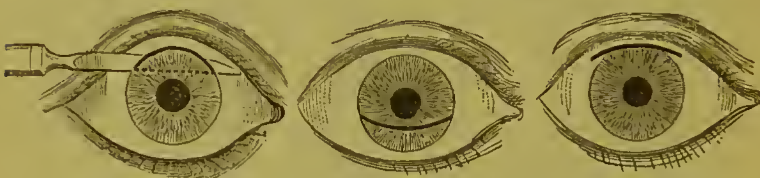

Fig. 48.—Incisions for extraction of cataract.
A. Small flap. *B*. Oblique corneal section. *C*. Linear incision.

ing the curette through the wound and allowing the solution to run along its groove; in a few minutes the iris will become deadened, and iridectomy can be painlessly performed, cocaine applied to the conjunctiva alone does not deaden the iris.

Small flap with iridectomy (Fig. 48 A) is far the best method of extraction.

The lids should be kept open by the wire speculum, the eyeball fixed by seizing the conjunctiva with the toothed forceps, a flap section should then be made by transfixing the eyeball through the sclero-corneal margin with the straight extraction (Graefe's) knife (Fig. 47 *c*), and then cutting out in the line of the sclero-corneal junction.

* The flap is shown rather too small.

The section may be made either upwards or downwards, and the point of transfixion should be about one-third of the distance from the horizontal corneal meridian to the upper or lower margin of the cornea. The flap should include about one-third of the cornea.

If iridectomy has not been previously performed, a piece of the iris corresponding in width to a moderately dilated pupil should next be excised from the upper segment (see Iridectomy).

The next step is to lacerate the capsule. The operator should fix the eye, and draw it gently downwards with the toothed forceps, then introduce the sharp hook through the incision and freely lacerate the capsule with it. The cataract can then be removed by making gentle pressure with the curette upon the eyeball, near the lower margin of the cornea, the globe being steadied and held in position by fixing the conjunctiva with the toothed forceps.

The nucleus and bulk of the cataract having escaped, the curette should be passed gently over the surface of the cornea from all directions towards the incision, so as to press out any cortical substance that may be left, and if any blood or portions of lens remain in the incision they must be carefully removed, so as to insure perfect coaptation of its margins; the speculum should then be removed, and both eyes bandaged in the usual way.

Oblique corneal section.—This operation often goes by the name of Bader's or Liebreich's operation, when the section is made downwards; Lebrun's "extraction by small median flap," when the section is made upwards. It would appear, however, that the term "oblique corneal section" expresses all and dispenses with much unnecessary prolixity.

The instruments required are a thin straight cataract

knife, a sharp hook and curette (Fig. 47, *c*, *d*, *a*). (For the position of patient and surgeon see Fig. 32, p. 204). The lids should be held open and the eyeball steadied by the operator's fingers as detailed under solution.

The incision may be made either upwards or downwards (fig. 48 B), by passing the straight knife through the sclero-corneal margin on the outer side at a point (puncture) corresponding to the horizontal corneal meridian, into and across the anterior chamber, out at a corresponding point on the inner side (counter-puncture), and then cutting forwards by a sawing movement, *obliquely*, through the cornea, midway between the pupil and upper or lower corneal margin; the former if the incision is made upwards, the latter if it is made downwards. In entering the knife and passing it across the anterior chamber, care must be taken to keep its edge directed forwards towards that part of the cornea which it is desired to incise; if the knife is rotated in any way after the anterior chamber has been opened, the aqueous humour will escape and the blade become entangled in the iris.

The capsule should next be lacerated by scratching it with the sharp hook, and the lens removed by gently pressing on the eyeball at the upper or lower margin of the cornea aided by gentle counter-pressure near the opposite margin. The pressure can best be made with the thumb of one hand and the fore-finger of the other placed upon the surface of the partially closed lids; the position of the incision near the centre of the cornea, however, will not allow the lens to be pressed out immediately. Before attempting to squeeze out the cataract its margin must be brought opposite the incision by gently pressing upon the globe above or below, according as the section has been made upwards or downwards.

The bulk of the cataract having been removed, care must be taken to get away any soft cortical substance or fragments of lens that may be left. The soft matter can be removed by gently rubbing the cornea; small hard fragments must be drawn out by the curette or a small scoop. The whole of the cataract having been removed, the iris, which will in all probability have somewhat prolapsed, must be replaced with the curette, some solution of eserine dropped into the eye to keep the pupil contracted and so reduce the risk of recurrence of the prolapse, and both eyes carefully bandaged.

Linear extraction.—In this operation the cataract is removed through a linear incision, partly in the sclerotic and partly in the cornea, or altogether in the former; usually associated with iridectomy, performed at the time of extraction of the cataract, or some months previously.

By linear incision is generally understood an incision made in the same direction as a straight line drawn from the centre of curvature of the cornea to its circumference (one of its radii). Many modifications of linear incision are practised, but only one will be described here. The instruments required for linear extraction are a wire speculum (Fig. 35), toothed forceps (Fig. 38), a straight cataract knife, a curette, sharp hook (Fig. 47 *c, a, d*), iris scissors (Fig. 43), and iris forceps (Fig. 42).

The operation should be performed thus, and, as in the other forms of extraction, the incision may be made either upwards or downwards (for position of patient and operator see Fig. 32, p. 204):—The lids should be kept open by a wire speculum, and, supposing the incision to be made upwards, the globe must be drawn gently downwards with the toothed forceps, holding the conjuuctiva and subconjuntival fascia close to the lower margin of the cornea; then with the straight

cataract knife puncture and counter-puncture should be made in the *sclerotic*, just beyond the sclero-corneal margin, the knife entering at a point on the outer side of the globe, situated about two-thirds of the way between the horizontal meridian of the cornea and its upper margin, and emerging at a corresponding point on the inner side; the edge of the knife should then be directed nearly straight forwards, and by a sawing movement made to cut its way out through the cornea, at a short distance within its upper margin (Fig. 48 C).

The remaining steps of the operation are the same as above described under small flap operation.

The incision for linear extraction, as already stated, may be made downwards as well as upwards, the former method of operating being much the easier, and not requiring the aid of an assistant.

The same objections apply to extraction downwards as to iridectomy in the same direction, but the results obtained are equally good as from upward sections and the ease with which the operation can be performed quite counter-balances any objections which may be made on the score of disfigurement.

Extraction of cataract by a traction instrument.—Cataract can be removed by a traction instrument, either through a flap section or a linear incision peripherally situated, iridectomy being performed in either case.

Whichever incision is made, the eyelids should be kept open with the speculum, and the globe fixed with the toothed forceps, while the section is made and during the subsequent removal of the lens.

The traction instrument employed is either a scoop or a sharp hook (Fig. 47 *e*, *d*).

Removal of cataract by the scoop (scoop extraction).—Scoop extraction can be accomplished

thus:—The section having been made and iridectomy performed, the convex surface of the scoop should be pressed gently upon the more peripheral margin of the incision, so as to cause it to gape somewhat; the instrument should then be passed with the utmost gentleness through the incision, beneath the margin of the lens, along its posterior surface and beyond its posterior pole, until the lens lies well in its concavity, and it should then be carefully withdrawn, carrying the cataract with it, the removal being assisted by gentle pressure on the exterior of the globe.

A wire loop designed by Dr. Bell Taylor may be used instead of, and in the same manner as, the scoop to which it is to be preferred.

Removal of cataract with the sharp hook (sharp hook extraction).—The hook should be passed well behind the lens in the same manner as the scoop, fixed into its posterior surface, and then carefully withdrawn, carrying the lens with it. Two sharp hooks may be used instead of one, and should be fixed into the lens at different points, so as to prevent it rolling round (as sometimes happens when only one hook is used), instead of passing in the desired direction.

After removal of the lens by either method both eyes should be bound up in the usual way.

Suction.—The removal of the cataract by suction is a proceeding highly recommended and often practised by some surgeons. As far as my own practice is concerned I have long given the operation up. It is said to be useful in cases where the lens has become nearly or entirely fluid, as occurs in many instances of traumatic cataract, and frequently after a needle operation has been performed. Such cases are, however, in my opinion best treated by extraction through a very small flap section.

The instruments required are a wire speculum, toothed forceps; broad needle, and suction tube (Figs. 49, 50). Before operating the pupil should be well dilated with atropine. (For position of patient and surgeon see Fig. 32, p. 204).

The eye must be cocainised or the patient placed under the influence of an anæsthetic. The lids should be kept

Fig. 49.—Needle for making incision in suction operation. (*From* Byrant).

open by the wire speculum, the eyeball fixed by the toothed forceps, and a small linear incision made in the cornea with the broad needle, about midway between its summit and margin, in any convenient position.

The operator should then place the mouth-piece of the suction tube in his mouth, pass its nozzle through the incision and behind the softened lens, and, by sucking

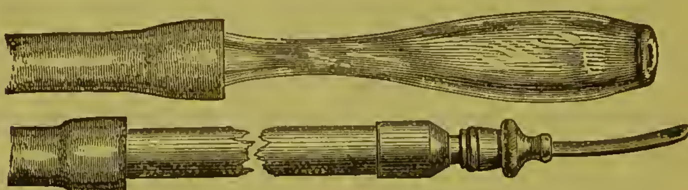

Fig. 50.—Suction tube.

The mouth-piece and nozzle are here shown, they are connected by about 18 inches of rubber tubing.

(*From* Bryant).

gently, remove as much lens matter as will come away easily. No force must be used, and if any portion of the lens be too hard to pass easily into the tube it may be left to become absorbed or be dealt with on a future occasion. When as much lens as will easily come away has been extracted the suction tube should be removed, the speculum taken out, a drop of solution of atropine

placed between the lids, and the eyes bandaged in the usual way. The bandage should be continued, and the pupil kept dilated with atropine, until all irritation has subsided.

Extraction through a very small flap section.—A flap rather more than half the size of that shown at fig. 48 A, should be made in the same manner as described under small flap extraction. Slight pressure on the globe close to the corneal margin at a point opposite the section aided, if necessary by the curette placed between the lips of the incision will readily effect the escape of any softish lens, and the necessity for introducing the suction tube and the danger of too hard sucking are avoided. Iridectomy should be performed if the iris prolapse and will not remain in its proper position when returned. Eserine should be dropped into the eye immediately after the operation so as to draw the iris away from the wound and the eye bandaged. As soon as union has taken place (in about 24 to 36 hours); atropine and vaseline should be smeared on the lids and on a piece of lint covering them so as to dilate the pupil and prevent adhesions taking place if iritis supervenes.

Before proceeding to remove the lens by either of the foregoing methods, the capsule if not previously ruptured should be freely torn up with the sharp hook. In any case, if the soft lens-matter does not readily escape, thoroughly stirring up with the hook will much facilitate matters.

Accidents During Extraction of Cataract.

Premature escape of aqueous humour.—If care is not taken in making the section the aqueous humour may escape too soon, and the movements of the knife be hampered by the iris falling forwards. Should this

happen, the knife must be carefully withdrawn and the section completed with scissors.

Bleeding into the anterior chamber.—In some cases hæmorrhage from the cut iris or conjunctiva takes place to such an extent as to fill the anterior chamber with blood and hide the cataract entirely from view.

If the blood does not flow out easily on placing the curette between the lips of the incision and making gentle pressure on the cornea the operation should be discontinued, the eye bound up, and left till the blood has become absorbed, unless the lens-capsule has been lacerated, in which case the lens *must be removed at all risks*, or it may swell, press upon surrounding parts, set up inflammatory action, cause increase of tension of the globe, and very probably lead to destruction of the eye.

Prolapse of vitreous humour.—If undue pressure is exerted on the globe during extraction the suspensory ligament of the lens gives way and a prolapse of vitreous follows. Should the prolapse of vitreous occur before the escape of the lens, the cataract should be removed as quickly and gently as possible by the aid of a traction instrument.

Prolapse of vitreous is more likely to occur if the humour is abnormally fluid. The accident may give rise to no bad results, but is sometimes followed by a form of chronic choroiditis which ultimately destroys the eye.

If vitreous has been lost great care must be taken that none remains between the lips of the incision; perfect coaptation having been secured the eye must be firmly bandaged so as to keep the lids immovable, and prevent further prolapse.

Displacement of the cataract.—In some cases, on an attempt being made to press out the lens, the suspensory ligament gives way, and the cataract, instead of coming forwards into the anterior chamber

passes behind the iris or sinks backwards into the vitreous chamber; it should, if possible, be removed by the scoop, loop or sharp hook. If left within the globe it will probably act as a foreign body, set up inflammation, and destroy the eye.

After-Treatment of Extraction of Cataract.

Immediately after the operation each eye should be covered with two folds of lint wetted with boracic acid lotion and secured by a bandage, which has been contrived for the purpose by the late Mr. Dunnage,* of the Central London Ophthalmic Hospital. The patient should then be put to bed, where he should remain for three or four days.

The lint must be kept constantly wet for the first week, and fresh pieces should be applied every day.

On no account should the eye be examined until the end of the first week; if the lids remain in a normal condition we may rest assured that all is going on well, and opening the eye too early can do no good, and may do a great deal of harm.

At the end of a week the eye may be opened and its condition ascertained. Should the section be healed, the anterior chamber re-established, and no signs of inflammatory action present, the sound eye can be safely left uncovered, the one that has been operated on being kept bandaged with dry lint, and a large green shade worn over both. At the end of three weeks the bandage may be removed from the eye on which extraction has

* Dunnage's bandage consists of a piece of material of an open texture—through which water will easily run—of such a length as to cover both eyes, and leave some to spare. To each end of this piece are attached tapes by which the bandage is secured.

been performed, but the shade or protectors should be worn until all undue vascularity has subsided.

At the end of about two months (if there is no intolerance of light or irritability of the eye) glasses should be ordered, two pairs being given; one for going about, and one for reading; convex 13 D will usually be found most suitable for the former purpose, convex 16 D for the latter. But should the patient have been myopic or hypermetropic before the operation, glasses weaker or stronger than these may be required.

This is the usual course of cases of extraction of cataract; all do not, however, go on so favourably.

A day or two days after the operation the patient may complain of severe pain in the eyeball, temple, and brow, and on removing the bandage the lids may be found puffy and red, or perhaps much swollen.

These symptoms always indicate inflammation of some of the ocular structures. Slight puffiness without pain, and with slight mucous or muco-purulent discharge, means only conjunctivitis, need occasion no anxiety, and only requires fomentations with hot water once a day. Redness and swelling of the margin and surface of the lid mean iritis; leeches (three to six) should be applied to the temple, and small doses of mercury (gr. ii. of pil. hydrarg., gr. ½ of pulv. opii, three times a day) should be given; the eyelids should be well smeared with vaseline containing gr. viii. of sulphate of atropine to ℥ i., and lint well covered with the same should be bandaged over the eye instead of the boracic acid dressing. Iritis will probably proceed to a favourable termination, but may cause partial or complete blocking of the pupil. In some cases irido-cyclitis or irido-choroiditis may be set up and eventually destroy the eye.

Great swelling of the lids, (the hollow between the

margin of the orbit and lids being filled up), means that suppuration has commenced in the cornea, or that a suppurative inflammation of all structures of the eye except the sclerotic, (panophthalmitis) has been set up

The suppuration commences at the incision, may destroy a portion of the cornea next it, and then stop leaving the greater part of the cornea clear. It may destroy the cornea entirely, or go on to panophthalmitis; in both these latter cases the eye as a visual organ is lost, but it may quiet down and keep more or less its natural curvature, or shrink. An eye lost after cataract extraction from whatever cause, must always be looked upon as an eye lost from injury, and must be excised if symptoms of irritation occur in its fellow, or that too may be destroyed by sympathetic ophthalmia.

Suppurative inflammation is best treated by fomentations, sedatives to relieve pain, good diet, and a moderate amount of stimulants. When panophthalmitis is fairly set up, a crucial incision should be made through the cornea or its remains, and poultices applied.

A not uncommon cause of pain and irritation after cataract extraction, is the occurrence of entropion of the lower eyelid; this must be remedied by operation (see operations on the eyelids).

Causes of unsatisfactory results of cataract operations.—The success of an operation for removal of cataract may be marred by partial or complete closure of the pupil following iritis, by obstruction of its area with opaque lens capsule, or capsule thickened by inflammatory products, by opacity in the vitreous, or by a chronic form of corneitis causing more or less permanent corneal opacity.

Closure of the pupil can be remedied by iridectomy, in bad cases the operation may require to be

repeated, and we should never give up hope of restoring some sight so long as any iris remains, *provided the perception of light remains normal.*

Capsular obstructions can usually be torn through with cataract needles. Any needle operation can be performed with the eye under the influence of cocaine. If only a thin film of capsule is present it can easily be torn through in the following manner:—Dilate the pupil as much as possible with atropine, hold the lids open with a wire speculum, fix the eye with the toothed forceps, pass a cataract needle through the cornea near its margin at any convenient point, push it on across the anterior chamber to the middle of the pupil, and make two or three cuts in the opaque capsule, the vitreous will push through the rent and keep open a clear pupil; drop some more atropine into the eye and bandage it for a few days. It may be necessary to repeat the operation.

Denser opacities cannot be dealt with quite so easily. They can, however, be torn asunder with two needles:—One needle having been introduced as described, and pushed through the opaque membrane should be held steadily in position, a second needle should then be passed from the opposite side of the cornea, and pushed through the capsule close to the first; the needle points should then be separated, when a rent will probably be made. If a satisfactory pupil is not obtained by simply separating the needles, one may be rotated round the other so as to roll up the capsule, the two should then be separated as widely as possible. Care must be taken not to push the needles deeply into the vitreous, or stir it up too freely.

After the operation, atropine should be instilled, and the eye bound up.

Very dense membranes cannot be torn by needles.

They may be cut across with scissors (see iridotomy), or in very bad cases removed with forceps.

The greatest caution must always be exercised in meddling with opaque capsule. Simple needle operations rarely do harm if ordinary gentleness is used, but forcible tearing and especially attempting the removal of capsule with forceps are liable to be followed by secondary glaucoma, severe iritis or cyclitis, or even by panophthalmitis.

Nothing can be done to remedy vitreous opacities; they are sometimes associated with retinal detachment. Corneitis should be treated by sedative fomentations and atropine, and any constitutional treatment that may appear indicated adopted; it is often of gouty origin; its course is extremely chronic, and it is very rebellious to treatment.

CHAPTER VI.

Extirpation of the Eyeball—Abscission and Evisceration.

Removal of the eyeball is called for under the following conditions:—

1. In all cases of injury causing complete disorganisation, with collapse of the globe and escape of its contents.

2. In cases where one eye, having been damaged by injury or disease to such an extent as to render it *practically useless* (more especially if the presence of a foreign body be suspected) becomes irritable or painful, and the sound eye appears threatened by sympathetic ophthalmia.

3. In cases where an eye lost from injury or disease, and *quite blind*, is a source of annoyance, even though the other eye be not threatened.

4. In cases where the globe has become the seat of malignant disease.

Extirpation of the eyeball should be thus performed (for position of patient and operator see Fig. 32, p. 204). The instruments required are a wire speculum, toothed forceps, a pair of blunt-pointed scissors, curved on the flat (Fig. 51) and a strabismus hook. The patient being thoroughly under the influence of an anæsthetic, the operator should place the wire speculum between the lids, then by the aid of the forceps and scissors, cut through the conjunctiva all round the cornea as close to its margin as possible; he should then, with the strabismus hook, take up the four recti muscles, one after the other, and divide them with the scissors, either the

external or internal rectus being cut at a little distance from the globe, so as to afford a hold for the forceps in the subsequent steps of the operation, and the other three muscles as close to it as possible.

The muscles having been divided, the hook should be made to sweep round the globe, so as to be sure that nothing is left uncut. By pressing the speculum backwards the eyeball will become dislocated in front of the lids, and then being steadied by holding the piece of muscle purposely left, with the forceps, the scissors should be passed behind it until their points are found to be in contact with the optic nerve, then slightly with-

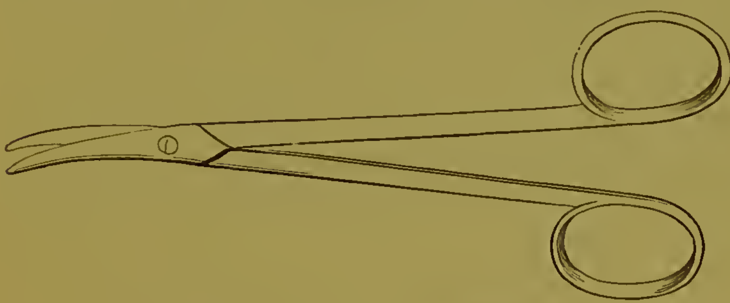

FIG. 51.—Extirpation scissors.

drawn, opened widely, pressed forwards again, and the nerve divided by a single cut.

As soon as the nerve has been cut through, the eyeball will be almost free, being held only by the oblique muscles, which should be divided close to the sclerotic. Should there be free hæmorrhage the speculum may be left between the lids, a piece of sponge pressed firmly into the orbit, and secured by a turn of bandage; when all bleeding has ceased the sponge should be removed with the speculum, and two small pads of wet lint and a bandage applied. Should the hæmorrhage be but slight, two or three small pads of lint, wet with boracic acid lotion, must be laid over the closed lids, and secured

by a bandage in the same manner as in other operations on the eye. The patient may get up and go about as usual on the day after the operation. The dressing should be applied fresh every day for a week, after that a shade must be worn till an artificial eye can be inserted. In about a month or six weeks an artificial eye may be ordered.

Fitting an artificial eye.—The fitting of an artificial eye may be left to the eye maker. As a rule the tissues of the orbit should be allowed to heal firmly, which will have taken place in the time specified (a month or six weeks) but cases sometimes occur in which it is necessary that an artificial eye should be inserted very much sooner, and it is well to remember that it is possible, though not advisable, to excise the eyeball, and replace it by an artificial one as soon as the bleeding has stopped. Thus, a person may be so circumstanced that he or she is obliged to have an eye removed, which although sightly, does not see, and has to appear before the world again very shortly with no sign of mutilation.

The usual practice is to insert an eye which is too small at first, and in the course of a few days replace it by a larger one, which should be worn for a short time longer, and then be replaced by one as large as can be comfortably worn. The surgeon should always see his patient after the artificial eye maker has done with him, and if not satisfied with the result should send him back for another eye to be made. The artificial eye should be removed at night and thoroughly cleaned, and replaced in the morning.

To insert the artificial eye, draw down the lower lid, push the eye beneath the upper lid till its lower edge is well within the border of the lower lid, then let the lower lid return to its natural position. To remove it, draw down the lower lid until the edge of the eye becomes

exposed, then with the finger nail, a hair-pin, small spud made for the purpose, or any article that may be at hand, lift the edge of the eye over the margin of the lid and allow it to slide out on to the cheek.

It is well to carry out these manipulations over a bed or sofa, as the eye is very likely to be let fall, and will break if it comes in contact with any hard substance.

An artificial eye wears out in from twelve to eighteen months.

Abscission.

Abscission is the removal of the portion of the eyeball (including the ciliary region) situated in front of the attachments of the recti muscles, these being left intact. The object of this operation is to leave a movable stump, on which an artificial eye can rest and be moved in harmony with the movements of the sound one.

Abscission is indicated in staphyloma occupying the whole or greater part of the former situation of the cornea, the remainder of the globe retaining its normal curvature.

The operation should be thus performed (for position of patient and operator see Fig. 32, p. 204). The instruments required are a wire speculum, toothed forceps, strabismus scissors, a triangular cataract knife, a curved needle and silk. The patient being thoroughly under the influence of an anæsthetic, the wire speculum should be placed between the lids, the conjunctiva divided all round close to the corneal margin (as for extirpation) and dissected back to the desired extent.

Then with the curved needle a single suture should be passed through the edge of the divided conjunctiva at five or six different points, so as to surround the

wound in it in much the same manner as the string surrounds the mouth of an ordinary bag, and the ends of the silk left hanging on the patient's face.

The staphyloma, the whole of the ciliary body and sclerotic corresponding to it, should then be removed by transfixing the globe with the triangular knife, just in front of the insertions of the internal and external recti muscles, cutting out upwards in front of the insertion of the superior rectus and finishing the removal by a sweep of the knife in the opposite direction.

The silk should then be drawn up and tied, by which means the conjunctiva will be made to cover the wound in the globe, and lint wetted with boracic acid lotion, and a bandage applied. Some reaction often follows abscission, and a good deal of swelling of the lids and conjunctiva may occur. The patient should be kept in bed for two or three days, fresh dressings should be applied daily for a week, after which a shade only is required.

As soon as the parts have firmly healed (in the course of six weeks or two months) an artificial eye may be worn.

Abscission should be performed in preference to excision of the globe in children; the presence of the stump left prevents to a great extent the shrinking, or non-development of the orbit, which will occur if the eyeball is removed entirely. In older persons excision is generally to be preferred, as the stump left after abscission is liable to become troublesome, and in the very old is prone to suppurate.

Evisceration.

Abscission is rapidly being, and I think should be entirely, replaced by "evisceration" of the globe, an

operation which will probably take the place of excision in a large number of cases, possibly in all except those of malignant disease.

Evisceration can be performed as follows:—The position of patient and operator should be as at Fig. 32, p. 204. The instruments required are a needle armed with silk, fixing forceps, speculum, triangular cataract knife, excision scissors, a piece of india-rubber tubing about four feet long to act as a siphon and a vessel containing a solution of boracic acid (gr. x. to ℥j.).

The patient having been anæsthetised, the conjunctiva should be divided all round, close to the cornea, as for excision. The cornea should then be separated from the sclerotic by cutting all round the sclero-corneal junction with the triangular knife; the iris, ciliary body, and choroid, with the retina and vitreous enclosed, should then be removed by passing the excision scissors carefully between the choroid and sclerotic all round the interior of the globe, the sclerotic being meanwhile held by the cut margin with the fixing forceps. These parts may often be removed as a whole; if the choroid tears, any portions left should be brushed out with pieces of cotton-wool held in another pair of forceps, this must be done carefully as the object of the operation is to remove the whole of the contents of the eyeball, leaving nothing but the sclerotic. As soon as the evisceration has been completed, a stream of boracic acid solution should be directed from the india-rubber tube into the cavity of the sclerotic, and kept up until the bleeding, which is rather profuse, has materially lessened or stopped; two quarts or more of the solution may be required. Whilst the washing out is going on, a continuous suture should be passed through the cut edge of the conjunctiva in the same manner as described for abscission. When sufficient of the solution has been used, the suture should be

drawn tight, and the two ends tied together. A simple fold of lint wetted with boracic lotion should be laid lightly over the closed lids, and secured by a turn of bandage round the forehead, no pressure being applied over the lids, so as to give free exit for blood and discharge, if there be any; the lint should be kept wetted with boracic acid solution, and fresh pieces applied two or three times a day. Some swelling of the conjunctiva follows, and in some cases, a good deal of febrile disturbance, the temperature rising to 101° or 102° for a night or two after the operation. The patient should be kept in bed for two days or longer if necessary, and then allowed to get up and go about. The parts will have soundly healed in about a fortnight, and an artificial eye may be worn six weeks or two months after the operation. The result is a more or less movable stump on which the artificial eye rests, and with which it moves to a considerable extent.

CHAPTER VII.

PROTRUSION OF THE EYEBALL—AFFECTIONS OF THE ORBIT—TUMOURS OF THE EYEBALL, ETC.—PANOPHTHALMITIS—REMOVAL OF FOREIGN BODIES FROM THE INTERIOR OF THE GLOBE.

Protrusion of the eyeball.—As many diseases of the orbit and to a considerable extent tumours of the eyeball itself, cause more or less protrusion of the globe, it will be well to say a few words on this subject before describing the morbid changes which may give rise to it.

The symptoms are obvious enough, and do not require description. The causes are the following :—

1. Inflammation within the orbit, either with or without the formation of abscess.
2. Hæmorrhage into the orbit.
3. Vascular protrusion of the eyeball.
4. Exophthalmic goitre.
5. Tumours within the orbit; nodes, exostoses, malignant growths, cysts, nævi, etc.
6. Enlargement of the eyeball itself from (*a*) growths, malignant or simple; (*b*) inflammation and suppuration of the whole eyeball (panophthalmitis).
7. Paralysis of its muscles, allowing the globe to drop forwards, and thus assume an unusual prominence.

Double vision is *generally* complained of in protrusion of the eyeball if the sight of both eyes is fairly good. The ill effects of the abnormal position are seen both in the globe itself and in the lids. Should the protrusion be so great that the lids cannot be closed over the eyeball the cornea will be left unprotected and may become opaque, and afterwards ulcerate or slough. If the pro-

trusion continues for long the lids become distended and flaccid, their movements being much impaired; the tear puncta may also become displaced, giving rise to continual watering of the eye.

Treatment.—In all cases where the eyeball is healthy care should be taken to protect the cornea from injurious exposure, by drawing the lids over it and keeping them fixed by a compress and bandage, but in extreme cases the edges of the outer third of the lids must be pared, united by sutures, and allowed to heal firmly together. (See Operations on the Eyelids).

Inflammation within the orbit.—Inflammation may affect the soft tissues within the orbit, the periosteum, or the bone itself; it may end in resolution, the parts returning to their natural condition; chronic thickening may result, causing more or less permanent protrusion and impairment of the movements of the eyeball; or abscess may form, and in the case of periostitis or ostitis caries or necrosis of the bony walls may supervene.

Symptoms.—Inflammation within the orbit is accompanied by more or less febrile disturbance, pain of a throbbing character much increased by pressure, swelling of the conjunctiva and lids, more or less prominence and impaired movement of the eyeball, intolerance of light, and watering of the eye; it may be the result of cold, injuries, or general diseases, as erysipelas, and (in the case of periostitis) of syphilis, or may come on in debilitated states of the system, during recovery from acute diseases (scarlet fever, measles, etc.), or from over-lactation. It is not easy to distinguish inflammation affecting the soft parts only, from inflammation of the periosteum or bone.

Treatment.—Should consist in allaying pain and inflammation by means of opium internally, fomentations

of poppy-heads to the affected part, leeches to the corresponding temple (two to six in number), and rest in bed in a darkened room; any general medical treatment which may appear most applicable should also be employed.

For instance, if the patient is strong and healthy, low diet, purgatives, etc., should be had recourse to; if weakly, as during recovery from some acute disease, tonics and good diet should be prescribed. If the patient is the subject of syphilis this should be treated.

Abscess.—If the inflammation goes on to the formation of abscess, the symptoms are aggravated, the conjunctiva becomes more swollen, and in some cases almost covers the cornea, the lids are greatly swollen and red, the prominence and impairment of movement of the eyeball increase, and rigors may occur. Vision becomes misty, and in some cases all perception of light is entirely lost. After a time fluctuation may be detected; if left to itself, the abscess will burst, the pus being discharged either through the skin or conjunctiva. The abscess having been emptied, in favourable cases the swelling will disappear, the eyeball resume its natural position, and the opening heal. But in some cases, especially if the suppuration be associated with caries or necrosis of the bone, the abscess will remain open, or the orifice alone heal, the sac again becoming filled with pus.

Treatment.—As soon as the surgeon feels satisfied of the existence of pus in the orbit it should be evacuated; if fluctuation can be detected the diagnosis is easy enough, but even if this cannot be done, and suppuration is suspected an exploratory puncture should be made, when the escape of pus will clear up any doubt.

The best method of opening an abscess in the orbit is that recommended by Mr. Hilton for evacuating pus

situated at a depth from the surface amongst important structures. The operation should be performed as follows:—An incision having been made, either through the skin or conjunctiva, at that part where the eyeball appears most pushed away from the wall of the orbit, a grooved director should be thrust in (the surgeon bearing in mind the direction of the wall along which he is passing the instrument and the depth of the orbit). As soon as pus is seen escaping along the groove of the director a pair of small dressing forceps should be passed along it until their points are within the abscess; the blades should then be separated slightly and drawn out whilst so separated; a ragged opening will thus be left, which is not likely to close too soon, and the danger of cutting important structures will be avoided.

The greatest care must always be taken not to injure the eyeball. As the operation is very painful, an anæsthetic should be given.

Immediately after the operation search should be made by means of a probe for diseased bone or foreign bodies; if a foreign body or loose sequestrum is detected it should be at once removed; diseased bone, if still firm, may be left to itself, and will either come away spontaneously or may require removal at a later period. If the opening appears inclined to close too soon it should be kept open by means of a piece of lint passed into it; only light antiseptic dressings need be applied.

Periostitis or Ostitis followed by Caries and Necrosis of the Walls of the Orbit.

Symptoms.—The symptoms of periostitis or ostitis going on to caries or necrosis are similar to those above described, excepting, perhaps, that the pain is more

severe and often aggravated at night. This form of inflammation should always be suspected in persons suffering from syphilis, and occasionally nodes may be met with at the margin of the orbit or on the forehead; their existence should always lead the surgeon to suspect that the inflammation within the orbit is periosteal. When the abscess has formed and burst, or has been opened, the seat of inflammation becomes evident from the character of the pus, which is of that peculiar unhealthy and often bad smelling variety met with in abscesses connected with diseased bone, as well as from the condition of the opening, which remains patent and is surrounded by large unhealthy granulations, and from the fact that the bare bone can be felt with a probe passed through the opening.

Caries and necrosis usually end in recovery after a time, the diseased bone being thrown off and the sinus becoming closed. The disease generally attacks the margin of the orbit and often leaves cicatrices, which cause great disfigurement and deformity of the eyelid. Should caries or necrosis occur deeply in the orbit the results may be most serious, the optic nerve becoming affected and vision lost, or the disease may spread to the interior of the skull, set up meningitis, and cause death.

Treatment.—In the earlier stages the treatment should be the same as that described under inflammation and abscess of the orbit, but when the abscess has burst, or been opened, its cavity should be syringed out daily with some mild disinfecting solution; care must be taken to prevent its too early closure, by means of a piece of lint or fine drainage tube pushed into the sinus; exuberant granulations should be kept down by the application of nitrate of silver, and distortion of the lids, if likely to occur, must be prevented by uniting their edges (*see* Operations on the Eyelids).

If any pieces of bone are found loose they should be removed by operation.

Hæmorrhage into the orbit.—Orbital hæmorrhage may depend upon the spontaneous rupture of a vessel within the orbit, and if the amount of blood is considerable, produces displacement of the eyeball. The blood may become diffused, and appear beneath the conjunctiva, being subsequently gradually removed by absorption; occasionally, however, the clot becomes encysted, and permanent displacement of the eyeball results. Hæmorrhage into the orbit also occurs from foreign bodies entering it, and in fracture of its walls, frequently to a considerable extent; subconjunctival ecchymosis is a prominent symptom in some cases of fracture of the base of the skull extending through the roof of the orbit.

Hæmorrhage sufficient to cause displacement of the eyeball has occurred after the operation for strabismus.

Treatment.—In cases of spontaneous hæmorrhage light pressure should be applied to the eye by a pad of lint or cotton wool and a bandage. Where excessive hæmorrhage occurs after operations for strabismus a large pad of lint should be placed on the closed lids, and firm pressure by means of a bandage kept up for a few hours after the operation. Hæmorrhage from foreign bodies entering the orbit, or from fracture of its walls is only of secondary importance to the injury which caused it, and may be left to itself; it is of more interest to the general surgeon than the specialist.

Vascular protrusion of the eyeball.—This is the name applied, and very justly, by Mr. Thomas Nunneley (*Medico-Chir. Trans.*, vol. xlviii.) to a set of cases formerly considered to belong to the class of "aneurism by anastomosis," but which Mr. Nunneley shows differ in many essentials from the latter affection, both in their

clinical aspect and history. He has also had opportunities of verifying his diagnosis by post-mortem examination, and in no case has he met with an instance of the above-mentioned affection due to this cause. Mr. Nunneley has reported in all seven cases, and mentions some ten or twelve others described by various writers. The cases reported are chiefly either instances of traumatic aneurism, or aneurism arising spontaneously from rupture of a diseased artery in an elderly person; but in one case a cancerous growth was found involving the orbit and other parts.

The symptoms complained of by the patient are, noise in the head and feeling of tension, singing in the ears, pain in the orbit and eyeball, all of which are aggravated by stooping or exertion, but are nevertheless most annoying at night. These symptoms are accompanied by more or less protrusion and impaired mobility of the eyeball, dimness of vision, much congestion, principally venous, of the eyelids and conjunctiva, and chemosis; pulsation (which may be controlled by pressure on the carotid of the same side) in any part of the orbit and communicated to the eyeball; a large pulsating vessel is generally seen and felt at the inner part of the lower eyelid, and often a bruit heard on auscultation over the brow or other parts immediately adjoining the orbit. In some rare cases no pulsation can be detected.

In most cases the symptoms have come on at a varying time, after some injury to the head, a punctured or gunshot wound of the orbit, or have occurred spontaneously and suddenly.

The morbid changes met with in the three cases examined after death by Mr. Nunneley were in one (in which the disease commenced spontaneously, and the patient died sixteen days after ligature of the carotid) a dilatation of the carotid at the point of giving off the

ophthalmic branch, the dilatation being filled with and surrounded by coagulum; the ophthalmic artery itself was somewhat dilated, its coats thickened, and atheromatous in parts; two of its branches were much dilated and filled with clot. In another case, also of spontaneous origin, a circumscribed aneurism of the ophthalmic artery, close to its origin, was discovered. The third case was found to be one of cancerous disease within the orbit, associated with cancerous tumours, in other parts of the body.

In the majority of cases of "vascular protrusion" of the eyeball the disease is not within the orbit, but intracranial, the protrusion being dependent on obstruction to the return of venous blood, and analogous to the swelling and congestion seen in the limbs when the main artery is affected by aneurism.

It is easy to understand how, in a small and firmly bounded space, like the cavernous sinus, a very insignificant dilatation of the commencement of the ophthalmic artery, or of the carotid itself at any point within the sinus, or a small hæmorrhage from either, may prove a most serous impediment to the return of venous blood, much more so than the same amount of disease situated in the cavity of the orbit itself. A communication between the carotid artery and the sinus would have the same effect, and has been found to exist in some cases.

Nævus, as is well known, is not unfrequently met with in the orbit, but is, usually, easily enough diagnosed (see p. 297).

A case of traumatic aneurism of the orbit, which is, I believe, unique, came under my observation in September, 1873.

The patient, a young gentleman, was some two months previously, opening a hamper in which were some bottles of soda water; one of these burst, and a

large piece of glass was driven with considerable force into the left orbit, inflicting a wound in the upper eyelid, just external to the internal angular process of the frontal bone; the glass dropped out; sharp arterial hæmorrhage occurred, which was stopped by pressure; much ecchymosis of the lids followed. The wound healed, the swelling and ecchymosis disappeared, and all appeared to be going on well, but shortly before being seen by me the eyeball seemed to be somewhat protruded, and considerable congestion of the eyelids and conjunctiva was noticed. When first I saw the patient there was much venous congestion of the eyelids and conjunctiva (no chemosis), marked protrusion of the eyeball in a direction somewhat outwards; a small pulsating tumour could be distinctly felt near the inner angle of the orbit; a marked thrill was communicated to the eyeball, which could be felt on placing the hand upon the closed lids; a buzzing in the head was complained of, especially on stooping; there was a small linear cicatrix over the pulsating tumour, marking the seat of the original injury.

Ophthalmoscopic examination showed an extremely dilated and tortuous condition of the retinal veins, but detected no pulsation; there was no impairment of vision.

Pressure on the left carotid at once stopped the pulsation, and caused considerable decrease of the venous congestion.

Aneurismal varix was diagnosed. Perfect rest and pressure applied directly to the part were tried for some months without benefit. It was at length determined by the patient's medical attendant (Mr. Landsdowne of Clifton) to perform an operation; accordingly, an incision was made over the tumour, and several fair-sized vessels which appeared to communicate with it were tied; the wound healed kindly.

I saw the patient again at the beginning of the summer of 1874. The congestion had disappeared, the pulsation ceased, and the eyeball had returned to its natural position, the only sign of the disease remaining being a small linear cicatrix in the upper eyelid and a slight thickening near the inner angle of the orbit in the position previously occupied by the pulsating tumour.

Treatment.—Many of these cases recover without operative interference. Rest, low diet, with depressing remedies, as cold applied locally, and the administration of digitalis or antimony should always have a fair trial. Pressure applied locally, by means of a pad and bandage, should also be employed if it can be borne.

These means failing, recourse must be had to digital pressure of the carotid, kept up for some hours, the patient being under the influence of an anæsthetic, as pressure in the neck gives rise to such intolerable pain, that even the most resolute can only bear it for a few minutes at a time.

As a last resource, a ligature must be applied to the common carotid on the same side as the disease.

This operation was performed in all but one of Mr. Nunneley's cases with the best results. In a case under my own care ligature of the carotid was followed by complete subsidence of the symptoms.

Should a case similar to that reported above occur, the operation which proved so successful in it should be performed.

Exophthalmic Goitre.

This disease is characterised by protrusion of the eyeballs, impairment of the movements of the lids, and diminished sensibility of the cornea and conjunctiva, accompanied by disturbance of the heart's action and

systolic murmurs in the heart and great blood-vessels of the neck, together with dyspnœa and enlargement of the thyroid body.

Treatment.—Should the protrusion of the eyeballs be very extreme, ulceration and perforation of the cornea may occur; this may be guarded against by protecting the cornea with a small pad and light bandage applied over the closed lids, or the outer third of the palpebral aperture may be closed by operation. These patients are, however, extremely intolerant of anæsthetics. General medical treatment should be employed; for this the reader is referred to works on general medicine.

Tumours of the Orbit, Orbit and Eyeball, and Eyeball alone.

Tumours of the orbit alone are—exostoses, nævi, cysts, nodes, and malignant growths. Those of both orbit and eyeball are usually malignant, and commence primarily either in the eyeball or some of the other structures within the orbit. Those of the eyeball alone are also for the most part malignant, but simple and cystic growths are occasionally met with.

Before attempting the removal of any orbital tumour, we should ascertain whether or no it is external or internal to the cone formed by the recti muscles. The diagnosis can be made by testing the mobility of the eyeball. If the globe moves freely, or its movements are but little impaired, the tumour is probably outside the cone. If movement is greatly interfered with the growth is within the cone. In the former case removal should be effected through an incision in the skin over the most prominent part of the growth, the eyeball with

its muscles being held out of the way. In the latter the incision should be made through the conjunctiva. Tumours commencing about the base of the skull; in the antrum or nasal fossæ may invade the orbit. Their consideration belongs to the domain of general surgery.

Tumours of the Orbit alone.

Exostoses.—These are of two kinds, either hard, ivory-like masses consisting of compact bony tissue; or soft spongy growths, of an open cancellated structure.

Bony tumours are generally met with as hard, more or less circumscribed outgrowths of varying size, growing either from the bone itself or from the periosteum. They affect the orbit alone, or may project into neighbouring cavities, a fact which should be borne in mind when attempting their removal.

Treatment.—Should exostosis of the orbit give rise to inconvenience, it may be removed by operation. An incision should be made, parallel with the margin of the orbit, over the most prominent part of the growth, which, having been thoroughly exposed, should be removed in any way which may appear the most effectual, the greatest care being taken to guard the eyeball from injury, and, if possible, to preserve the continuity of the lachrymal canaliculi and position of the tear puncta. In the removal of the hard ivory exostosis the greatest difficulty will be experienced, some hours' patient work with chisel and mallet being occasionally required. The operation can, however, be greatly facilitated by boring through the base of the tumour with a drill worked by a "dental engine." The surgeon who undertakes the removal of such a growth should be aware of the extreme difficulty to be sur-

mounted, and arm himself with a corresponding amount of patience and perseverance before commencing the operation. The soft, spongy growths are much more easily removed; the tumour, having been thoroughly exposed, can usually be broken off with strong forceps. Should the growth be on the inner side of the orbit, and much force be used in its removal, the cavity of the nose may be opened and the operator may be rather alarmed at seeing large quantities of air blown out with the blood. This accident, however, need occasion no uneasiness, as it makes no difference to the progress of the case; nevertheless, care should always be taken not to fracture the orbital walls; should the fracture take place in the roof, instead of the inner wall, the consequences would be most disastrous, as the cavity of the cranium would be opened.

Nævi are not uncommonly met with in or about the orbit, situated generally near its margin, or in the eyelids, but sometimes growing deeply in the orbital cavity. They present much the same characters as in other situations, being soft to the touch, of a bluish colour, and becoming harder and more tense during crying or straining.

Treatment.—The nævus should, if possible, be excised. Subcutaneous ligature is most applicable in some cases, but care should be taken to prevent as much as possible subsequent cicatrisation, in consequence of the deformity it may produce in or about the eyelids. Other cases may be treated by setting up adhesive inflammation within the growth, by the use of the galvanic or other cautery by electrolysis, or by passing a number of small setons soaked in perchloride of iron through its substance. The setons should be left in until they have set up a slight amount of suppuration. Injection of the growth with perchloride of iron, solution

of tannin, or chloride of zinc, may also be tried, but the greatest caution is necessary, as the operation has occasionally been followed by the sudden death of the patient.

Cysts.—Various kinds of cysts are met with in and about the orbit, the most common being the congenital dermoid cyst (*see* Operations on the Eyelids). Simple cysts, probably the remains of hæmorrhages, and cysts connected with the lachrymal gland, are also met with. Hydatids have occasionally been seen. Cysts or hydatids can be cured by puncture and removal of part or, if possible, of the whole cyst.

Nodes.—Periosteal nodes are not unfrequently met with; they occur as hard and sometimes painful tumours, usually situated somewhere about the margin of the orbit, but sometimes deep in its cavity. The existence of a node deep in the orbit should always be suspected in cases of paralysis of any of the ocular muscles, displacement of the eyeball, etc., more especially if these symptoms are associated with nodes on the forehead or margin of the orbit, or other symptoms of syphilis. Nodes gradually disappear under anti-syphilitic treatment.

Distension of frontal sinus.—Appears as a swelling situated above the inner canthus, at the inner angle of the orbit; the character of the swelling depends upon whether the bone forming the boundary of the sinus is intact or has become absorbed and perforated; in the former case the tumour is hard and resisting, resembling an exostosis; in the latter it is soft and fluctuating, resembling a mucocele, it is, however, higher up above the tendo oculi, instead of below and behind it, and communicates a peculiar crackling sensation to the touch.

We are often told that the tumour is smaller when

lying down than when the patient is standing or sitting. Epiphora may occur, not, however, due to obstruction of the lachrymal passages, but to displacement caused by encroachment of the tumour.

A diagnosis is easily arrived at in any case, whether the bone is perforated or not, by puncturing the swelling, when a glairy tenacious yellowish or greyish fluid will escape, and a probe passed through the opening will be found to have entered a large cavity, which extends for some inches upwards to the forehead, and backwards beneath the base of the skull. In many cases we get a history of injury, such as a blow at the inner angle of the orbit, or across the bridge of the nose. The sequence of events being closure of the communication between the sinus and nasal cavities, and retention and gradual accumulation of secretion.

Treatment.—An opening must be made into the swelling, either through the skin near the inner angle of the orbit, or through the conjunctiva at the inner canthus; a probe pushed through into the superior meatus of the nose, and, guided by a finger, passed up the nose till it emerges at the corresponding nostril. A drainage tube should then be attached to the probe, which should be pulled back carrying the drainage tube with it. The tube must be drawn well out through the wound, and its upper extremity fixed to the forehead with strapping, its lower extremity, which should project slightly beyond the nostril, should be secured to the cheek by a piece of silk and strapping. The tube must be worn for at least three months, and the cavity must be daily syringed out with an antiseptic solution. If the swelling is simply incised the cavity will refill, but if effectually drained it either fills up, or a permanent opening into the nose is established, through which the secretion can escape. The drainage tube should be changed

as often as may appear necessary. The wound, whether in the skin or conjunctiva, closes without trouble after removal of the tube.

Sarcomatous or Cancerous Growth may be met with and when possible they should be removed by operation.

Tumours of Orbit and Eyeball.

The tumours affecting the orbit and eyeball are malignant growths which have usually commenced within the eyeball and afterwards perforated the tunics and implicated the tissues of the orbit. They are generally of the variety known as melanotic sarcoma.

The appearance of the tumour varies according to the stage of growth at which it has arrived. In an advanced case a large fungoid mass of a dirty greyish or brownish colour, having a foul surface covered in parts with dark scabs, in others discharging thin unhealthy matter occasionally mixed with blood, will be seen protruding between the swollen and distended lids. On closer examination the eyeball (as such) will be found nearly destroyed, portions of the sclerotic alone remaining in their proper position. The movements of the globe are much impaired, or altogether wanting, the growth having implicated the whole of the tissues of the orbit in one malignant mass. It is curious how the growth as it advances beyond the limits of the eyeball loses its melanotic character and becomes less deeply coloured.

The constitutional disturbance in these cases is often severe, especially when the disease is far advanced.

Treatment.—The treatment of these growths depends much on the extent to which the tissues of the

orbit are implicated, and the state of the patient's health.

If the tumour is fairly circumscribed, so that there appears to be a reasonable hope of removing the whole, and the patient is in such a state of health as to preclude the likelihood of similar deposits in other parts, extirpation of the eyeball and other diseased tissues should be performed, any portions of growth that may be left being destroyed by applying to the interior of the orbit strips of lint covered with a paste of chloride of zinc and starch in equal parts. But should the orbit be so filled by cancerous deposit that there appears to be little hope of removing the whole growth, more especially if the patient is in a cachectic condition, no operation should be thought of, and the surgeon must content himself with palliative treatment, as opiates to relieve pain, and attention to the general health.

Tumours of the Eyeball.

1. Glioma.
2. Sarcomata, melanotic, round, and spindle-celled.
3. Carcinoma.
4. Tubercular deposit.
5. Pseudo glioma.

Glioma is most commonly met with in children, but occasionally in older persons.

Sarcomata, melanotic, round, or spindle-celled, are usually met with in persons of from forty to sixty years old, and occasionally in early adult life. The melanotic is the most common form.

Carcinoma has been met with in persons past the middle period of life, but its occurrence is rare.

Glioma commences in the retina; it presents the fol-

lowing appearance:—Should the patient be a child, it will generally be healthy looking, and present no signs of cachexia; attention has been drawn to the eye from a peculiar glistening appearance of the pupil (cat's eye). On examination the surgeon will notice the peculiar reflection through the pupil, which is generally somewhat dilated but movable in the earlier stages. Examination, both by means of the ophthalmoscope and by lateral illumination, will show a light coloured growth projecting into the vitreous chamber, either as a single prominence or in nodules; the growth will gradually increase, its surface become covered with blood-vessels, the retina be displaced, and sight soon entirely lost.

As the disease progresses the tension of the globe increases, the pupil becomes widely dilated and fixed, the iris pushed forwards and nearly in contact with the cornea, and the lens opaque, preventing a view of the interior of the eye; the whole globe now gradually enlarges, frequent inflammatory attacks occur, the sclerotic becomes thinned, and at last, if the growth is allowed to remain, a slough forms near the centre of the cornea, which ruptures, and a fungoid bleeding mass protrudes.

The increase of the growth now becomes much more rapid, and it may grow to a considerable size in a short time.

As soon as the growth becomes exposed to the air it commences to discharge thin sanious pus and blood, and becomes more or less coated with a dirty yellow scab. The eyelids become inflamed and swollen, sharp attacks of hæmorrhage may take place, the general health suffers, and the patient dies from exhaustion or from extension of the disease to the brain.

Glioma in its earlier stages is likely to be confounded with tubercular deposit within the eyeball or pseudo glioma, but it is not likely to be thus mistaken after perforation has occurred.

Treatment.—The only treatment of glioma is extirpation of the globe, and this should be done as soon as the nature of the disease has been made out; but however early the operation may be performed, the disease is most likely to return, either in the optic nerve or brain.

Melanotic sarcoma, or black cancer, affects persons past the middle of life; it is characterised by the development of black pigment-cells; it may grow either from the interior or exterior of the eyeball, but generally commences in the choroid. It is said not to be so liable to recur as glioma. Round- and spindle-celled sarcomata also commence most commonly in the choroid.

Treatment.—Early extirpation of the eyeball. In all cases of excision for malignant growths, the optic nerve must be cut as far back as possible.

Carcinoma, as above stated, is rarely met with.

Tubercular deposit.—The appearance of this deposit within the eyeball closely resembles that met with in the early stages ot glioma. The patients are usually children. The deposit is in the choroid; there is the peculiar glistening appearance of the pupil noticed in glioma, and blood-vessels may be seen upon the surface of the growth; the retina is more or less displaced by fluid between it and the choroid, and floats in the vitreous chamber. The growth goes on increasing, the pupil becomes dilated, its mobility is destroyed; the lens becomes opaque, the sclerotic thinned, the whole eyeball somewhat enlarged, and suppuration may occur; supposing the disease to have gone on up to this point, there is nothing by which it can be distinguished from glioma.

After this the difference becomes manifest; the growth, instead of increasing, destroying the cornea,

and projecting from the eyeball, commences to shrink, and with it the eyeball, which becomes soft, and is at length reduced to a small irregular mass. The growth of tubercular deposit may become arrested at any time, and the shrinking of the eyeball commence; in this, again, it differs from glioma.

Pseudo glioma.—Appearances somewhat similar to glioma, and scarcely to be diagnosed from the foregoing, are also produced by inflammatory deposit in the vitreous; the disease has received the name of "pseudo glioma." It is possible to distinguish the two by the fact that in glioma the anterior chamber is in the early stages of good depth; in pseudo glioma it exists only at the periphery. Moreover, in pseudo glioma there are often evident signs of past iritis, and the tension of the globe is below par. There is often a history of some brain attack, accompanied by inflammation of the eye, and we are sometimes told that patients are subject to, or have had, fits.

Treatment.—Tonics and good generous diet. In all doubtful cases, and in those in which there is much pain, the eye should be excised.

Inflammation and Suppuration of the Eyeball (Ophthalmitis or Panophthalmitis).

Ophthalmitis is usually the result of injuries, especially of those complicated by the lodgment of a foreign body within the globe; it unfortunately not unfrequently follows operations for cataract, and is occasionally met with during erysipelas, pyæmia, scarlet fever, etc., and sometimes in women after confinement, especially if the strength is lowered by over-lactation. The disease may begin in any of the structures of the eyeball except the

sclerotic. Should it commence in the cornea and iris, the former will become cloudy, and soon abscesses will form in its substance, the iris likewise becoming discoloured and covered with pus. The suppuration may stop short here, the cornea and iris being alone destroyed, and the eyeball left with some perception of light (*see* Suppuration of Cornea and Iris). Should the disease, however, commence in the deeper structures of the eyeball, rapid impairment of vision will take place, all perception of light being lost in perhaps a few hours.

If the pupil is clear, pus may be seen behind it, but in most cases all appears dark; the movements of the eyeball are much impaired, and the lids and conjunctiva considerably swollen. As the disease advances the eyeball becomes enlarged and its tension increased, and if left to itself will rupture and discharge its contents, much to the patient's relief. The globe afterwards shrinks to a small button-like stump. Pain is very severe in many cases, but occasionally is altogether wanting. Suppuration of the eyeball rarely sets up sympathetic changes in the other eye.

Treatment.—This depends upon the cause of the disease, and whether one or both eyes are affected. Should the inflammation depend upon the lodgment of a foreign body, this should be removed without any reference to its position or the state of vision; if the eye has still good perception of light it will certainly be destroyed if nothing is done, and whatever difficulties the surgeon may encounter he cannot possibly make matters worse, and he should not hesitate an instant, or he will lose his chance of preserving any sight that may be left.

Any foreign body having been removed, the surgeon's next care should be to relieve pain, and if possible check inflammation.

These indications are best carried out by the application of leeches (if the patient is strong, and can bear blood-letting), by opium internally, and by the constant use of sedative fomentations, the best being Fotus Belladonnæ, (made by dissolving a drachm of extract of belladonna in a pint of warm water) mixed with an equal quantity of Fotus Papaveris, (made by boiling an ounce of poppy-heads in a pint of water); a piece of rag or lint soaked in this mixture as hot as it can be borne should be kept constantly applied to the affected eye. Poultices may also be employed. Most patients will require the administration of a fair amount of stimulant, good food, with iron and quinine.

When suppuration has been fairly established, and all perception of light lost, the eyeball must be treated as an ordinary abscess, and the pus let out by incision.

If suppuration occurs in both eyes, as is sometimes the case when it arises from idiopathic causes, especially pyæmia, treatment must be directed towards the relief of pain. If the patient escapes with life, he will certainly be blind.

Removal of foreign bodies from the interior of the globe.—Foreign bodies in the anterior chamber can be removed with iris forceps; if fixed in the iris a portion of iris should be removed with the foreign body. If lodged in the lens, the lens should be extracted with the scoop or loop, (see p. 268). From the vitreous a foreign body may be removed with forceps made for the purpose, but the operation is extremely difficult and the result will probably be a failure.

Chips of iron or steel can be removed from any part of the interior of the globe by the electro-magnet. Mr. Simon Snell, of Sheffield, has had wide experience in the removal of foreign bodies by this means. The following is his description of his instrument (fig. 48) and its mode of use.

"The electro-magnet, as depicted in the engraving, is connected at one end to a battery; for this purpose a quart bichromate battery is convenient. At the other extremity the soft iron case is tapped to receive various terminals, curved or straight, short or long, etc., as any particular case may require. It has been used successfully in the inventor's and also in other hands, for the removal of chips of steel or iron from all parts of the

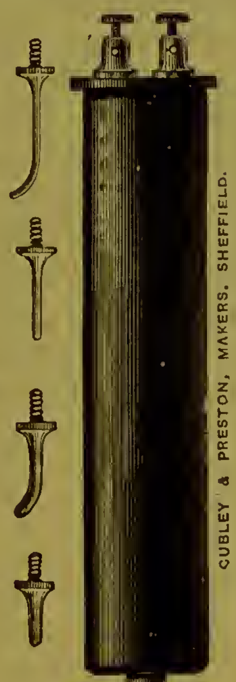

FIG. 48.

eye, as well as from the orbit. To be employed with the greatest chance of success and of recovering vision, it should be used as soon as possible after the accident; and this remark has particular reference to foreign bodies in the vitreous, in which region, it may be added, some of its most striking successes have been obtained. At the same time, in some instances after the fragment

of steel or iron has been located for a considerable time, the value of the electro-magnet has been equally shown.

In recent cases the point of the electro-magnet may be inserted through the still unclosed wound; in other instances the original wound may be re-opened, or a fresh one made, and then a situation the most suitable for reaching the foreign body should be selected. For fragments in the vitreous, the sclerotic should be incised away from the ciliary region and towards the equator, the direction being meridional. After the magnet has been used the conjunctiva should be united by a suture over the deeper wound.

As an aid in diagnosis the electro-magnet has proved, also, of great service. A foreign body of doubtful nature has revealed its character by being seen to move on the approach of the magnet, and in the case of a foreign body situated for long in the vitreous, its free mobility on bringing the electro-magnet in contact with the globe, afforded valuable information as to the possibility of its removal.

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